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

APR 2 0 2001

10 CFR 50.4
10 CFR 50.90

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

Gentlemen:

In the Matter of	)	Docket No(s). 50-390
Tennessee Valley Authority	)	

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 1 - REVISION TO THE SPENT FUEL POOL COOLING ANALYSIS METHODOLOGY

In accordance with the provisions of 10 CFR 50.4 and 50.90, TVA is submitting a request to amend the Final Safety Analysis Report to reflect a change in the Spent Fuel Pool (SFP) Cooling Analysis Methodology. TVA proposes to increase the existing WBN SFP heat load limit from its current value of 32.6 MBTU/HR. Such a change will provide the capability to off-load the core during outages as early as 100 hours after shutdown. In addition, the change will compensate for the projected increase in SFP decay heat from tritium production activities. The proposed change to the allowable limit will effectively increase the heat load capability of the spent fuel spool cooling system up to a new value of 47.4 MBTU/HR. As required by the recent revision to 10 CFR 50.59, TVA is submitting this revised methodology for NRC review and approval.

TVA has determined that there are no significant hazards considerations associated with the proposed change and that the change is exempt from environmental review pursuant to the provisions of 10 CFR 51.22 (c)(9). The WBN Plant Operations Review Committee and the TVA Nuclear Safety Review

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Board have reviewed this proposed change and determined that operation of WBN Unit 1 in accordance with the proposed change, will not endanger the health and safety of the public. Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and enclosures to the Tennessee State Department of Public Health.

Enclosure 1 to this letter provides the description and evaluation of the proposed change. This enclosure provides a discussion of the change in analysis methodology that is required to take advantage of actual system operating data. This enclosure includes TVA's determination that the proposed changes do not involve a significant hazards consideration. In addition, an environmental impact consideration is provided.

Enclosure 2 contains copies of the appropriate UFSAR pages marked up to show the proposed changes.

Enclosure 3 provides the analyses associated with the four systems affected by the methodology change. As NRC is aware, the staff reviewed the NDP-98-181, "TPC Topical Report" and issued NUREG-1672, "Safety Evaluation Report (SER) Related to the Department of Energy's Topical Report on the Tritium Production Core" documenting that review. Because the systems affected by the methodology change involve four of the 17 interface items identified in NUREG-1672 associated with SFP heat load, they are addressed in the form and format provided for in that document.

TVA requests that approval be provided approximately 30 days prior to beginning the Unit 1 Cycle 4 refueling outage.

There are no new regulatory commitments in this submittal. If you have any questions about this change, please contact me at (423) 365-1824.

Sincerely,

P. L. Pace
Manager,
Site Licensing and Industry Affairs

Enclosures
cc: See page 4

Subscribed and sworn to before me
on this 20th day of April 2001.

E. Jeannette Long
Notary Public

My Commission Expires June 27, 2001

cc (Enclosures):

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1
DOCKET NO. 390

PROPOSED METHODOLOGY CHANGE
DESCRIPTION AND EVALUATION OF THE PROPOSED CHANGE

I. DESCRIPTION OF THE PROPOSED CHANGE

In order to accommodate earlier off-loading of the core consistent with existing Technical Specification limitations on fuel movement (100 hours), TVA proposes by this submittal to augment its analysis of record which develops an alternate analysis that increases the maximum allowable SFP decay heat load up to a maximum of 47.4 MBtu/hr by taking credit for actual (lower) Component Cooling System (CCS) water temperatures and actual (lower) SFP heat exchanger fouling factors. Although this appears only to be a change in input values, the approach as to how these values are used is different. Therefore, TVA has considered this use as a methodology change.

Due to this change certain portions of the Updated Final Safety Analysis Report (UFSAR) will require modifications. For the specific UFSAR changes, see the page markups provided in Enclosure 2 of this submittal. However, even with these changes, the maximum design basis temperature for SFP remains unchanged and is bounding for higher decay heat loads. Since this revision is considered a methodology change, TVA requests NRC's review and approval for this change.

In addition to the above, NRC is aware that WBN Unit 1 has been selected by the Department of Energy (DOE) to provide irradiation services for tritium producing burnable absorber rods (TPBARs) in support of maintaining the nation's tritium inventory. As a result of TPBAR irradiation, there will be a small increase in decay heat loads placed into the SFP. TVA's existing analysis of record utilizes design basis values and bounding fuel discharge scenarios for predicting maximum SFP temperatures. This analysis determines the limiting decay heat loads for the pool. The UFSAR also allows placement of spent fuel into the pool regardless of discharge scenario, provided that the maximum allowable spent fuel heat load is not exceeded. This proposed change will allow TVA to offset the increase in heat load due to planned TPBAR production activities.

II. REASON FOR THE PROPOSED CHANGE

These changes are being made to address the increased heat load being placed into the SFP as a result of earlier refueling offloads and the irradiation of TPBARs. This analysis methodology change takes advantage of actual system operating data.

III. SAFETY ANALYSIS

TVA proposes to increase the existing WBN SFP heat load limit from its current value of 32.6 MBtu/hr. Such a change will compensate for the projected increase in SFP decay heat resulting from off-loading the core during outages as early as 100 hours after shutdown. The change will also compensate for the projected increase in SFP decay heat resulting from planned tritium production activities. The proposed change to the allowable limit will effectively increase the heat load capability of the spent fuel pool cooling system up to a new value of 47.4 MBtu/hr. Exceeding the lower design value is possible by taking credit for actual (lower) fouling of the SFP cooling system heat exchanger, and by taking credit for actual (lower) CCS temperatures. Analyses have been performed that support the proposed change. The results of the analyses show that the maximum spent fuel temperature for single train SFP cooling operation will not be increased, that localized boiling within the hottest fuel assembly will not occur, and that existing design limitations on heat removal systems will not be exceeded.

Current UFSAR Description of SFP Cooling System

UFSAR Section 9.1.3 states that the spent fuel pool cooling and cleanup system (SFPCCS) for WBN is sized to handle full core off-loads. The FSAR reflects a limiting value of decay heat that can be placed in the SFP, based on outage specific decay heat analysis performed for each outage. This approach provides a more realistic means (based on a quantitative limit instead of an off-load scenario based limit) of assuring compliance with the maximum allowable design basis decay heat load. Each outage a core specific and real time SFP decay heat assessment is prepared, which considers core operating parameters such as average fuel burn-up, interim trips, and coast-downs, etc. to develop pre-outage data for expected core and SFP decay heat. Procedures are in place to assure that at no time during core off-loading activities will the design basis limits of the SFPCCS be exceeded. Compliance with these limiting values provides assurance that, should a train of SFPCCS fail, maximum analyzed temperatures of the SFP and attendant decay heat removal system piping will not be exceeded.

The current UFSAR recognizes that a complete loss of SFP cooling (loss of two trains) would ultimately result in a SFP boiling condition. Mitigation of such an event is provided by multiple sources of makeup water to ensure the fuel storage racks and their contained fuel assemblies are always submerged by at least 10 feet of water. One of the multiple sources of makeup water includes the fire protection system, a safety grade supply of water. SFP heat up rates and time to boil estimates are provided in the UFSAR, Table 9.1-1.

The UFSAR discusses the maximum local water temperature and maximum local fuel temperature and the possibility of nucleate boiling on the surface of the fuel assemblies. Existing analysis have shown that for any scenario with at least one SFPCCS train available, localized boiling does not occur within the fuel assemblies. The decay heat flux of the rods is greatest at the fuel mid-height. Mid-height fuel cladding temperatures were calculated based on no blockage, partial blockage, and off-center placement of an assembly in a rack cell, respectively. Local maximum water temperatures were calculated for the no blockage, partial blockage, and off-center placement cases, respectively. The local saturation temperature at the top of the racks is greater than any calculated local water temperature, which precludes the possibility of nucleate boiling. Additionally, the local saturation temperature is greater than any calculated fuel cladding temperature, which would preclude the possibility of film boiling at the surface of the fuel rods.

Safety Analysis of Proposed Change

The existing WBN SFP heat load limit is 32.6 MBtu/hr. The proposed change to the allowable limit will effectively increase the heat load capability of the SFP cooling system up to a new value of 47.4 MBtu/hr. This higher allowable heat load is based on an alternate analysis performed utilizing actual system operating parameters. Exceeding the lower design value of 32.6 MBtu/hr will only be permitted under consideration of actual fouling of the SFP cooling system heat exchanger, and by taking credit for actual (lower) Component Cooling System temperatures.

SFP Heat Exchanger Fouling Factor

The analysis of record utilized design fouling factors of 0.0005 ($hr*ft^2*°F/Btu$) for both the tube and the shell side fouling. Actual fouling of the SFP heat exchangers has been found to be considerably less than design, with minimal negative trending over a long period of time, based on Sequoyah experience. This experience is consistent with expectations, given that both the CCS and the SFPCCS streams are clean water systems, approaching demineralized water in purity and clarity. Any particulate impurities introduced in the SFP during fuel movement operations would not be sufficient to foul the heat exchangers, as the water velocity in the SFP is very low. Any significant introduction of particulate impurities would adversely affect optical clarity of the SFP requiring fuel movement operations to cease. Therefore, the possibility of sudden fouling of the SFPCCS heat exchangers during fuel off-load operations is not credible.

The conditions required for fouling of the heat exchanger are not present in the SFPCCS. Actual data to date from Sequoyah Nuclear Plant (SQN) suggest low fouling rates of the heat exchanger over 20 years without cleaning. The use of this new methodology will require the use of certified Measuring and Test Equipment (M&TE) under written procedures for the determination of heat exchanger fouling factors prior to taking credit for this methodology. Due to the high purity of the coolant and cooled streams, and the proven history to date of low fouling, high fouling rates or other deviations to any established trend are not likely. Analyses performed with less than design fouling indicated significant benefit can be obtained in removing additional heat load from the SFP.

Component Cooling System Maximum Water Temperature

The analysis of record utilized design maximum values for CCS temperatures for the cooling medium on the shell side of the SFP heat exchangers. The maximum design temperature for CCS during refueling outages is 95°F. This value, however, is very conservative relative to the actual amount of heat being rejected to the CCS system. The design basis for the CCS system included significantly higher decay heat loads based on Residual Heat Removal (RHR) system heat loads shortly after shutdown. By the time the core is completely off-loaded, the RHR heat load is essentially zero. By increasing the flow of essential raw cooling water (ERCW) to the CCS heat exchanger to its design maximum allowable flow, CCS maximum temperature can be decreased to values less than the 95°F design value, even when considering design ERCW temperature and design fouling of the CCS heat exchanger.

Results of Alternate Analysis

By performing multiple analyses of SFP thermal performance at varying fouling factors from 0.0005 to 0.0001 ($hr*ft^2*°F/Btu$) and decreased CCS temperatures, a series of curves have been developed to provide operator guidance for an increase in allowable SFP decay heat. Analyses were performed for the limiting case of single train operation, in which the allowable design heat load was increased up to a maximum without exceeding the maximum design SFP temperature. Final curves of allowable decay heat vs. CCS Temperature and SFP heat exchanger fouling were developed which included a margin to account for inaccuracy inherent in reading graphs, and to add additional modeling conservatism. The curves provide design guidance for use in procedures which allow increased decay heat load in the SFP based on actual values for CCS temperature and SFP heat exchanger fouling.

A complete loss of SFPCCS (two trains) could result in a SFP boiling event in less than 4 hours. The alternate analysis has shown that even with higher allowable decay heat loads in the SFP, adequate sources for makeup water exist to allow sufficient time (over three days) to mitigate such an event, without reducing the SFP water level to unacceptable levels (10 feet above fuel storage racks). While the alternate analysis has shown a decrease in the time to react to a complete loss of SFP cooling, the resulting time available to mitigate such an event remains acceptable. Additionally, the analyses for loss of cooling events all considered steady state heat loads from the fuel. There is low probability of reaching an unacceptable level of coolant in the SFP. A loss of two trains must first be postulated coincident with maximum heat load in the SFP, after which there exists over three days to restore cooling. The actual heat load in the SFP would decay during the three days to levels which would not support a boil-off rate in excess of makeup capability. Multiple sources of makeup water (one qualified) exist to maintain and restore SFP level. Therefore, based on these factors, assurance is provided that the proposed change will not unacceptably decrease any margin of safety associated with SFPCCS operation or storage of spent fuel.

As a result of higher allowable heat loads in the SFP, the previous localized boiling analysis of record has been impacted. The localized boiling analysis was re-performed consistent with existing analysis methodologies except the rack and pool area were modeled using a three dimensional nodalization, instead of two dimensional. The inputs to the analysis were revised to be consistent with the higher proposed maximum allowable decay heat value (47.4 MBtu/hr). The results of the analysis show that while the margin to localized boiling has decreased, localized boiling within a rack will not occur. The analysis specifically concluded that:

1) the maximum local water temperature in the fuel storage racks was less than the local saturation temperature of the water, and

2) the bounding local fuel cladding temperature in the racks, determined by adding the bounding temperature difference between cladding material and water in the racks to the maximum local water temperature, was less than the local saturation temperature.

The following is a tabulation of specific SFP design values and parameters for both the existing design limiting conditions and the proposed values based on the alternate analysis:

WBN SPENT FUEL POOL DESIGN PARAMETERS		
Parameter	**Existing Design Value**	**Proposed Value (Alternate Analysis)**
Maximum Allowable Decay Heat Load	32.6 MBTU/Hr	32.6 - 47.4 MBTU/Hr See Note 1.
SFPCCS Flow	2300 GPM per Hx	2300 GPM per Hx
CCS Flow	3000 GPM per Hx	3000 GPM per Hx
Allowable Tube Plugging	5 %	5 %
Tube-Side Fouling ($hr*ft^2*°F/Btu$)	0.0005	0.0005 - 0.0001
Shell-Side Fouling ($hr*ft^2*°F/Btu$)	0.0005	0.0005 - 0.0001
Maximum CCS Temperature	95°F	95 - 80°F (Note 1)
Maximum SFP Temperature (1-Train)	159.24°F	159.24°F
Maximum SFP Temperature (2-Train)	129.30°F	129.30°F
Average Time to SFP Boiling	5.24 Hours	3.4 Hours
Average SFP Heat-Up rate	10.2°F/Hr	15.54°F/Hr
Average Boil-Off Rate	70.20 GPM	102 GPM
Time until only 10 feet of water over racks - without makeup	43 Hours	29.8 Hours
Time until only 10 feet of water over racks - with 55 gpm makeup	200 Hours - Assuming constant decay heat. See Note 2	76 Hours
Margin to Localized Rack Boiling	9.6°F	6.8°F

Notes:

1. The range of values represent allowable heat loads based on specific combinations of heat exchanger fouling between 0.0005 and 0.0001 ($hr*ft^2*°F/Btu$) and actual CCS temperatures between 95 to 80°F.
2. If credit is taken for decreasing core decay heat energy during the 200 hour period, the 10 feet above rack level is never reached at a makeup rate of 55 GPM.

Summary

The SFPCCS has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with specific requirements regarding SFP heat exchanger fouling and CCS temperature. The SFPCCS system can also accommodate the additional SFP heat loads imposed by tritium production activities. The increased heat load in the SFP can be safely removed via associated heat removal systems within existing design basis analyses.

IV. NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

In accordance with the provisions of 10 CFR 50.4 and 50.90, TVA is submitting a request to amend the Final Safety Analysis Report to reflect a change in the Spent Fuel Pool (SFP) Cooling Analysis Methodology. TVA proposes to increase the existing WBN SFP heat load limit from its current value of 32.6 MBTU/HR. Such a change will provide the capability to off-load the core during outages as early as 100 hours after shutdown. TVA has concluded that operation of Watts Bar Nuclear Plant (WBN) Unit 1 in accordance with this proposed change does not involve a significant hazards consideration. TVA's conclusion is based on its evaluation, in accordance with 10 CFR 50.91(a)(1), of the three standards set forth in 10 CFR 50.92(c).

A. The proposed methodology change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

The spent fuel pool cooling and cleanup system (SFPCCS) will see higher heat loading for the spent fuel as a result a 100 hour core offload as well as tritium producing burnable rod (TPBAR) irradiation. The analysis methodology change takes advantage of operating data as input into the SFP cooling analysis assumptions. Specifically, by taking credit for actual (lower) fouling of the SFPCCS heat exchangers and using actual component cooling system (CCS) temperatures, higher allowable heat loads can be safely placed within the SFP without exceeding existing design limitations. The increased quantity of heat being rejected to the CCS system is well within the system's design capability. The actual SFP cooling system is not being modified from what was previously evaluated and will continue to provide cooling as previously described. Existing maximum SFP temperatures will not be exceeded. Should loss of all cooling (loss of two trains) occur, ample time and sources for providing makeup water, are available, therefore there is no increased probability for SFP boil-off to uncover the stored spent fuel. Since the stored fuel will remain covered, there is no increase in radiological effects of such an event.

Therefore, the proposed methodology change does not increase the probability or consequences of an accident previously evaluated.

B. **The proposed methodology change does not create the possibility of a new or different kind of accident from any accident previously evaluated.**

The SFP cooling system will see higher heat loading for the spent fuel as a result a 100 hour core offload as well as TPBAR irradiation, the methodology change takes advantage of operating data as input into the SFP cooling analysis assumptions. The actual SFP cooling system is not being modified from what was previously evaluated and will continue to provide cooling as previously described. The current UFSAR recognizes that a complete loss of SFP cooling (loss of two trains) would ultimately result in a SFP boiling condition. However, the revised analysis has shown that even with higher allowable decay heat loads placed in the SFP, adequate sources for makeup exist to allow reasonable time (over three days) to mitigate such an event, without reducing the SFP water level to unacceptable levels (10 feet above fuel storage racks).

Loss of one train of cooling remains within the piping design analysis basis and the pool liner structural analysis since the peak temperatures projected are the same.

An error in the determination of the heat exchanger fouling factor would be detected by comparing trends from past determinations and through measured pool temperature.

Therefore, the proposed methodology change does not create a new or different kind of accident from any accident previously evaluated.

C. **The proposed methodology change does not involve a significant reduction in a margin of safety.**

This methodology change further refines assumptions made in the SFP cooling analysis based upon operating data. The SFP cooling system is not being modified and will continue to provide cooling as previously described. The current UFSAR recognizes that a complete loss of SFP cooling (loss of two trains) would ultimately result in a SFP boiling condition. However, the revised analysis has shown that even with higher allowable decay heat loads placed in the SFP, adequate sources for makeup exist to allow adequate time (over three days)to mitigate such an event, without reducing the SFP water level to unacceptable levels (10 feet above fuel storage racks). While the revised analysis has shown a decrease in the time to react to a complete loss of SFP cooling, the resulting time available to mitigate such an event is acceptable. Additionally, the analyses for loss of cooling events all considered steady state heat loads from the fuel. Since a loss of two trains must first be postulated, over three days exist to restore cooling, heat load decreases over the three days, and multiple sources of makeup (one qualified) exist, adequate assurance is provided that the proposed change will not involve a significant reduction in any margin of safety related to SFPCCS operation or storage of spent fuel.

The higher heat loads rejected to the CCS system are well within its design basis allowable heat loads experienced in other operating modes, therefore the CCS system can safety remove the increased decay heat from the SFP.

Therefore, this proposed methodology change does not involve a significant reduction in the margin of safety.

V. ENVIRONMENTAL IMPACT CONSIDERATION

The proposed change does not involve a significant hazards consideration, a significant change in the types of or significant increase in the amounts of any effluents that may be released offsite, or a significant increase in individual or cumulative occupational radiation exposure. Therefore, the proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed change is not required.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1
DOCKET NO. 390

UFSAR MARKUPS

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The SFPCCS incorporates two trains of equipment (plus a spare pump capable of operation in either train). The flow through the pool provides sufficient mixing to ensure uniform water conditions throughout the pool. For normal full core refueling and full core off load following normal refueling outages, the heat load in the spent fuel pool is limited to 32.6E+06 Btu/hr. Sufficient spent fuel pool cooling equipment is operated and the rate of fuel transfer is controlled to assure that the spent fuel pool temperature does not exceed 150°F during anticipated refueling activities. Operating procedures provide the controls to ensure these limitations are met. A decay heat calculation is routinely performed at the end of each operating cycle to produce heat decay vs. time curves for the core and spent fuel pool. This calculation can be used to determine the time to begin core off load and the rate at which the core can be off loaded.

9.1.3.1.2 Spent Fuel Pool Dewatering Protection

System piping is arranged so that failure of any pipeline cannot drain the spent fuel pool below the water level required for radiation shielding. A water level of ten feet or more above the top of the stored spent fuel assemblies is maintained to limit direct gamma dose rate.

9.1.3.1.3 Water Purification

The system's demineralizer and filter are designed to provide adequate purification to permit unrestricted access to the spent fuel storage area for plant personnel and maintain optical clarity of the spent fuel pool water surface by use of the system's skimmers, strainer, and skimmer filter.

9.1.3.1.4 Flood Mode Cooling

Section 2.4.14 presents the design basis operation of the SFPCCS when it may be used for reactor core cooling during flooded plant conditions.

9.1.3.2 System Description

The SFPCCS, shown in Figure 9.1-3, consists of two cooling trains (plus a backup pump capable of operation in either train), a purification loop, and a separate skimmer loop. The electrical logic control diagrams for this system are shown in Figures 9.1-4 and 9.1-5.

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Alternatively, up to 47.4E+06 Btu/hr. can be placed in the spent fuel pool within specific limitations on spent fuel pool cooling heat exchanger fouling and component cooling system supply temperatures less than the design temperature of 95°F.

Valves

Manual stop valves are used to isolate equipment, and manual throttle valves provide flow control. Valves in contact with spent fuel pool water are of austenitic stainless steel or equivalent corrosion resistant material.

Piping

All piping in contact with spent fuel pool water is austenitic stainless steel. The piping is welded except where flanged connections are used to facilitate maintenance and access to shadowed fuel storage cells.

9.1.3.3 Safety Evaluation

9.1.3.3.1 Availability and Reliability

The SFPCCS is located in a Seismic Category I structure that is tornado missile protected. Active components of the cooling portion of the system are located above the design basis flood level in the Auxiliary Building (Section 2.4.14). The SFPCCS heat removal equipment is designed to remain functional for the design basis earthquake and within the required stress limits for the operational basis earthquake.

REPLACE WITH

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Electrical power is supplied from emergency power buses to each of the spent fuel pool pumps. Each pump is connected to these emergency power buses so that it receives power from a separate diesel generator set should offsite power be lost. The use of emergency power buses assures the operation of these pumps for open reactor cooling during plant flooding conditions. This manually controlled system may be shut down for limited periods of time for maintenance or replacement of malfunctioning components. The pool is sufficiently large that an extended period of time would be required for the water to heat up appreciably if cooling were interrupted (see Table 9.1-1). In the event of a failure of one spent fuel pool pump, the backup pump would be aligned and operated. In the event of loss of cooling to one spent fuel pool heat exchanger, cooling of the spent fuel pool water could be maintained by the remaining equipment; however, the reduced heat removal capacity would result in elevation of the spent fuel pool water equilibrium temperature to a higher, but acceptable, temperature.

In the event that cooling capability were lost for an extended period, the pool water temperature would approach boiling. At the maximum decay heat production rate, the water loss by vaporization would be 70.2 gpm. A seismically qualified line is available from the common discharge of the refueling water purification pumps to the spent fuel pool cooling loop. All piping, valves, and pumps from the RWST to the common discharge of the refueling water purification pumps are seismically qualified. Other sources for makeup available are the demineralized water system and the fire protection system. The fire protection system is a Seismic Class I system. Hydrants located near the spent fuel pool are capable of supplying much more than 70.2 gpm.

REPLACE WITH

Hydrants located near the spent fuel pool alone are capable of supplying sufficient quantity of makeup water.

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For normal full core refueling and full core off load following a normal refueling outage, the heat load in the spent fuel pool is limited to 32.6E+06 Btu/hr. Sufficient spent fuel pool cooling equipment is operated and the rate of fuel transfer is controlled to assure that the spent fuel pool temperature does not exceed 150°F during anticipated refueling activities. Operating procedures provide the controls to ensure these limitations are met. A decay heat calculation is routinely performed at the end of each operating cycle to produce heat decay vs time curves for the core and spent fuel pool. This calculation may be used to determine the time to begin core off load and the rate at which the core can be off loaded.

The maximum local water temperature and maximum local fuel temperature have been determined to evaluate the possibility of nucleate boiling on the surface of the fuel assemblies. Analysis has shown that for any scenario with at least one SFPCCS train available, localized boiling does not occur within the fuel racks. The decay heat flux of the rods is greatest at the fuel mid-height. Mid height fuel cladding temperatures of 208.2°F, 217.1°F, and 208.9°F have been calculated based on no blockage, partial blockage, and off-center placement of an assembly in a rack cell, respectively. Local maximum water temperatures of 193.7°F, 204.1°F, and 195.2°F have been calculated for the no blockage, partial blockage, and off-center placement cases, respectively. The local saturation temperature at the top of the racks (240.7°F) is greater than any calculated local water temperature, which precludes the possibility of nucleate boiling. Additionally, the local saturation temperature is greater than any calculated fuel cladding temperature, which would preclude the possibility of film boiling at the surface of the fuel rods.

The total volume of water contained in the pool and cask pit area at the start of a loss of cooling scenario is 372,460 gallons. The expected water heat-up rates for a total loss of cooling capability accident for both a full core discharge and a full core discharge following a normal refueling are listed in Table 9.1-1.

9.1.3.3.4 Water Quality

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The approach to localized boiling within the racks has been evaluated for highest allowable spent fuel decay heat load (47.4 Mbtu/hr.). The conclusions of the evaluation indicate that greater than 6°F margin to localized boiling exists between the maximum calculated fuel clad temperature and the local saturation temperature even at the highest allowable heat load.

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access for plant personnel (refer to Section 12.3.2.2).

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Alternatively, up to 47.4E+06 Btu/hr. can be placed in the spent fuel pool within specific limitations on spent fuel pool cooling heat exchanger fouling and component cooling system supply temperatures less than the design temperature of 95°F. Specific guidance in the form of allowable SFP decay heat curves for less than design conditions of SFP heat exchanger fouling and shell side cooling temperatures has been developed. Decay heat curves are provided which allow outage specific variation in maximum SFP decay heat load based on known values of SFP heat exchanger fouling factors and CCS temperatures.

TABLE 9.1-1

SPENT FUEL POOL COOLING AND CLEANUP SYSTEM DESIGN PARAMETERS

Spent fuel pool storage capacity	1835(1) Assemblies
Spent fuel pool water volume, gal	372,460(2)
Nominal boron concentration of the spent fuel pool water, ppm	2000
Full Core offload case - 1680 assemblies stored plus an additional full core discharge (193) assemblies)	
Decay Heat production, Btu/hr	28.10×10^6
Spent fuel pool water temperature	
(two cooling trains in operation), °F	124.7
(one cooling train in operation, °F	151.2
Spent fuel pool water average heatup rate, °F/hr	9.88
Full core offload following a normal refueling storage case - 1600 assemblies stored plus one additional 80 assembly discharge, followed by a full core discharge (193 assemblies)	
Decay heat production, Btu/hr	32.60×10^6
Spent fuel pool water temperature	
(two cooling trains in operation), °F	129.3
(one cooling train in operation), °F	159.2
Spent fuel pool water average heat-up rate, °F/hr	10.20

REPLACE WITH ATTACHED INFORMATION

(1) Including high-density storage racks in the SFP and the cask pit.*
(2) Including cask pit area volume.

* The spent fuel pool has been licensed for storage of 1610 assemblies. The cask pit area is not licensed for spent fuel storage. The analysis using 1873 assemblies is conservative because higher heat loads and temperatures are generated than for an analysis using 1610 assemblies.

	Decay Heat Mbtu/hr	Maximum SFP Temperature (2-Train) °F	Maximum SFP Temperature (1-Train) °F	SFP Heat Rate °F/hr	Boil-Off Time to <10 ft Above Rack With No Makeup hrs
Normal Fuel Core Discharge Case-1680 assemblies [(a)]	28.10	124.7	151.2	9.88	47.7
Unplanned Discharge Case [(b)]	32.60	129.3	159.2	10.2	45.8
Maximum Allowed Decay Heat at Sub-Design SFP at Sub-Design SFP HX Fouling and CCS Temperatures	47.4	129.3	159.2	15.54	30

(a) Stored plus an additional full core discharge (193 assemblies)

(b) 1600 assemblies stored plus one additional 80 assembly discharge, following a full Core discharge (193 assemblies)

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1
DOCKET NO. 390

NUREG-1672
INTERFACE ITEM RESPONSES

1.5.8 Station Service Water System

NUREG-1672, Section 2.9.1, "The staff has reviewed the information presented by DOE and concludes that the effect on the SSWS is not safety significant, because the additional heat load introduced by TPBARs is very low and is indirectly transferred to the SSWS. The staff also agrees that, during the generic review of the TPC topical report, a quantitative analysis of the effect of the TPBARs on the SSWS was not appropriate. However, DOE concludes, and the staff agrees, that a quantitative analysis for the SSWS needs to be addressed by licensees participating in DOE's program for the CLWR production of tritium. The staff has identified this as an interface item that must be addressed by a licensee referencing the TPC topical report in its plant-specific application for authorization to irradiate TPBARs for the production of tritium."

Response

The design basis function of the Station Service Water System, which is called the Essential Raw Water Cooling System (ERCW) for WBN, includes providing a cooling loop for heat removal from the Component Cooling System (CCS). The ERCW supplies water from the Ultimate Heat Sink (UHS) (Tennessee River) to cool primarily safety related components. The CCS is the primary means for cooling the plant and removing residual decay heat during late stages of plant cooldown and during outages. The CCS intermediate cooling loop provides a heat sink to the Spent Fuel Pool Cooling and Cleanup System (SFPCCS) and Residual Heat Removal (RHR) system.

Tritium Impact on Spent Fuel Pool Decay Heat

TVA has prepared a quantitative analysis of expected spent fuel decay heat for both Tritium Production Core (TPC) and non-TPC cores. The analysis is based on comparative decay heat data prepared by TVA for a base non-tritium core, a TPC with 80 fresh fuel assembles (80-feed), and a TPC with 96 fresh fuel assemblies (96-feed). The results of the analysis show that the 80 feed case was limiting for decay heat (i.e, freshly offloaded core), and the 80-feed TPC core contributes a slightly higher decay heat over the non-TPC and the 96-feed TPC, due to isotopic composition differences between the base and TPC cores, for the same design basis reactor power level. The results of the analysis show that the 96-feed case was limiting for residual SFP heat (i.e., heat coming from total of previously discharged assemblies). TVA has assumed the worst case combination of these two heat sources. The TVA analysis has quantified the actual TPC impact on core heat loads at approximately 0.3 MWt, which included both the decay heat generated by freshly discharged fuel assemblies during a refueling outage, and the additional residual decay heat from the increased discharge rate (96 per outage) of fuel assemblies into the pool. This value is based on conservative, full pool SFP conditions.

Increased Spent Fuel Pool Cooling Heat Rejection on ERCW

The design basis analysis for the ERCW was evaluated for impact from the increased heat load from the CCS. The increased SFPCCS heat load rejection to the CCS will not result in a significant temperature increase in ERCW. The higher proposed increase in allowable decay heat load in the SFP is comprised of both TPC related decay heat increase and additional margin to allow off loading fuel to the SFP as early as 100 hours. The increase in decay heat associated with TPC is approximately 1 MBTU/Hr. The increase in allowable decay heat associated with reduced SFP heat exchanger fouling factors and lower CCS temperatures is approximately 14 MBTU/Hr. The proposed increase in decay heat above the approximate 1 MBTU/Hr associated with TPC, is decay heat that is shifted from the RHRS to the SFPCCS. The shifting results from the fact that fuel is either in the core being cooled by RHRS, or it is in the SFP being cooled by the SFPCCS. Since the decay heat has only shifted between systems, there is no net increase in CCS heat load on the ERCW system for this portion of the increased decay heat.

The design basis thermal analysis of record for the ERCW has sufficient margin to accommodate the increased CCS heat loads resulting from increased SFPCCS allowable decay heat loads. The increase in decay heat load is well within the design bases limiting heat load imposed on the ERCW during other modes of operation. Increased ERCW flows are the same higher flow rates that have been specified during other modes of operation. This small amount of increased decay heat and increased ERCW flow, when compared to the overall flow rates through the ERCW System, produces an insignificant increase in ERCW temperature (< 0.1°F) leaving the plant site.

The additional heat load rejected to the ERCW from the CCS heat exchanger results in minimally elevated piping temperatures. The downstream dilution effect, however, minimizes the impact of the elevated ERCW temperatures, as nearly all ERCW flows return to one of two headers prior to being discharged from the plant. The increased thermal loading on the piping analysis and support analysis of the ERCW System is well within existing design temperatures.

ERCW Summary

The ERCW System has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. The ERCW system can also accommodate the additional SFP heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with other design guidance regarding SFP heat exchanger fouling and CCS temperature. Tritium production activities will not have an adverse impact on the ERCW heat removal capabilities. For additional information on the SFPCCS, see Section 1.5.11.

1.5.9 Ultimate Heat Sink

NUREG-1672, Section 2.9.1, "DOE evaluated the effect of TPBARs on the ultimate heat sink (UHS) for the reference plant against the guidance of SRP Section 9.2.5. The acceptance criteria specified in the SRP are based on meeting the relevant requirements of GDCs 2, 5, 44, 45, and 46 of Appendix A of 10 CFR Part 50. DOE states that the heat removal capability of the UHS may be affected by the TPC from the increase in the spent fuel pool heat load during cooldown operations and the subsequent effect on the component cooling water system and the station service water system. DOE concludes that the effect on the ultimate heat sink should be analyzed on a plant-specific basis. The staff agrees with this evaluation because the design of the ultimate heat sink is very plant-specific. The staff has identified this as an interface item that must be addressed by a licensee referencing the TPC topical report in its plant-specific application for authorization to irradiate TPBARs for the production of tritium."

Response

The design basis function of the UHS is to provide an uninterrupted source of cooling water for decay heat removal.

The maximum allowable inlet temperature for the UHS is 85°F. The ERCW System is utilized to supply water from the UHS to cool primarily safety related components. The CCS is the primary means for cooling the plant and removing residual decay heat during late stages of plant cooldown and during outages via its intermediate cooling loop providing a heat sink to the SFPCCS and RHR system.

Tritium Impact on Spent Fuel Pool Decay Heat

See previous discussion under Interface Item 1.5.8.

Increased Spent Fuel Pool Cooling Heat Rejection on UHS

The design basis analysis for the UHS was evaluated for impact by the increased heat load from the SFPCCS. The increased SFPCCS heat load will not result in any significant temperature increase in the UHS. The increase in decay heat associated with TPC is approximately 1 MBTU/Hr. The increase in allowable decay heat associated with reduced SFP heat exchanger fouling factors and lower CCS temperatures is approximately 14 MBTU/Hr. This total increase in decay heat load is well within the design bases limiting heat load imposed on the ERCW and UHS during other modes of operation. Increased ERCW flows are the same higher flow rates that have been specified during other modes of operation. This small amount of increased decay heat and increased ERCW flow, when compared to the overall flow rates of the UHS through the ERCW System, produces an insignificant increase (< 0.1°F) in UHS temperature leaving the plant site. Since there is no significant increase, and since the ERCW has significant margin available, no changes to the ERCW temperature requirements are warranted.

UHS Summary

The UHS has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. The UHS can also accommodate the additional SFP heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with other design guidance regarding SFP heat exchanger fouling and CCS temperature. Tritium production activities at WBN will not have an adverse impact on the UHS heat removal capabilities. For additional information on the SFPCCS see Section 1.5.11.

1.5.11 Spent Fuel Pool Cooling and Cleanup System

NUREG-1672, Section 2.9.3, "The staff has reviewed the information presented by DOE and concludes that the calculations performed by DOE may not represent the actual increase in pool temperature from incorporation of the TPBARs. However, on the basis of information submitted by DOE in its letter dated January 13, 1999, the decay heat generated by the TPBARs is very low; each TPBAR generates less than 3 watts of heat at 150 hours after reactor shutdown. The maximum temperature increase of a TPBAR due to internal heat generation is less than 3°F. The reference plant could insert up to 3344 TPBARs in each reload. The total heat load increase due to TPBARs is about 0.003 percent compared with a 3565 MWT core rating of the reference plant. In considering its very low rate of heat generation, the staff concludes that the heat load increase from the incorporation of TPBARs in the spent fuel pool has an insignificant impact on the spent fuel pool heat load and the added heat load will be within the cooling capability of the SFPCCS. However, further analysis with reliable data is required to determine the actual impact of the TPBARs. A quantitative analysis to determine the absolute spent fuel pool temperatures must be performed by licensees seeking to utilize a TPC because the capacity of the spent fuel pool and its associated cooling system design are very plant specific. The staff has identified this as an interface item that must be addressed by a licensee referencing the TPC topical report in its plant-specific application for authorization to irradiate TPBARs for the production of tritium."

Response

The SFPCCS for WBN is sized to handle full core off-loads. In the 1996-97 timeframe, WBN underwent spent fuel storage rack additions, which included development of a new thermal hydraulic analysis based on standard NRC approved methodologies which are scenario based. During the rerack design change TVA recognized the impracticality of following a scenario based set of limits during plant operation for predicting SFP decay heat load. During the licensing efforts associated with the rerack efforts at WBN, the FSAR was revised to capture a limiting value of decay heat that could be placed in the SFP, based on outage specific decay heat analysis performed for each outage. This approach provided a more realistic means (based on quantitative limits instead of scenario based limits) of assuring compliance with the maximum allowable design basis decay heat loads that could be placed in the SFP at any time. Compliance with these limiting values provides assurance that, should a train of SFPCCS fail, maximum analyzed temperatures of the SFP and attendant decay heat removal system piping will not be exceeded.

UFSAR Section 9.1.3 now allows outage specific decay heat values to be used to determine the acceptable point in time that core off loading activities may commence without exceeding the design basis maximum allowable heat load. Prior to each outage, a core specific and real time SFP decay heat assessment is prepared, which considers core operating parameters such as average fuel burn-up, interim trips, and coast-downs, etc. to develop pre-outage data for expected core and SFP decay heat. Procedures are in place to assure that at no time during core off-loading activities will the design basis limits of the SFPCCS be exceeded. Adherence to the established limiting values of allowable SFPCCS decay heat ensures that the maximum SFP temperature does not exceed the pre-established maximum allowable design temperatures.

Tritium Impact on SFP Decay Heat

See previous discussion under Interface Item 1.5.8.

In addition, the impact of the higher heat load in the SFP could be mitigated by delaying the start of core off-load by 10 to 20 hours. Therefore from a design basis standpoint, it could be concluded that tritium production operations have no adverse impact on SFP heat loads or the ability of associated systems to remove the heat loads. However, since delaying the start of off-loading of the core during a plant outage results in a financial impact to plant operations, TVA has developed an alternate decay heat analysis which would compensate for this additional heat load and also accommodate core off-loading as early as 100 hours after shutdown.

Alternate SFP Decay Heat Analysis

An alternate analysis has been prepared by TVA to predict SFP transient thermal performance. This alternate analysis represents a change in methodology from the current analysis. The alternate analysis utilizes the same basic methodology, equations, and /or data as the current analysis, which was prepared in support of the previously licensed rerack effort. The alternate analysis, however, utilizes a modified methodology which allows varying SFP heat exchanger fouling and varying SFP heat exchanger coolant (CCS) temperature, to perform thermal balances on the SFP. Heat added by both core decay heat and residual decay heat from previously discharged batches provide the heat input parameter for the analysis. Since the new analysis is primarily an overall system heat balance, the source or mechanism for predicting actual core decay heat becomes less important. The new analysis models core decay heat post shutdown utilizing conservative core burnup generated using Nuclear Fuels computer code DHEAT, which is based on ANSI/ANS-5.1-1994, REG GUIDE 3.54, and NUREG/CR-2397. The overall system heat balance models SFP heat removal by the same two mechanisms as utilized in the existing analysis of record, via SFP heat exchangers and evaporative losses to ambient.

SFP Heat Exchanger Fouling Factor

The analysis of record utilized design fouling factors of 0.0005 for both the tube and the shell side fouling. Actual fouling of the SFP heat exchangers has been found to be considerably less than design, with minimal negative trending over a long period of time, based on Sequoyah experience. This phenomena is consistent with expectations, given that both the CCS and the SFPCCS streams are clean water systems, approaching demineralized water in purity and clarity. The conditions required for fouling of the heat exchanger are not present in this application. Actual data to date from SQN suggest low fouling rates of the heat exchanger over 20 years without cleaning. The use of this new methodology will require the use of certified Measuring and Test Equipment (M&TE) under written procedures for the determination of heat exchanger fouling factors prior to taking credit for this methodology. Sufficient testing will be performed to clearly establish the presence of any fouling trend. Due to the high purity of the coolant and cooled streams, and the proven history to date of low fouling, high fouling rates or other deviations to any established trend are not likely. Analysis performed with less than design fouling indicated significant benefit can be obtained in removing additional heat load from the SFP.

Component Cooling System Maximum Water Temperature

The analysis of record utilized design maximum values for CCS temperatures for the cooling medium on the shell side of the SFP heat exchangers. The maximum design temperature for CCS during refueling outages is 95°F. This value, however, is very conservative relative to the actual amount of heat being rejected to the CCS system. The design basis for the CCS system included significantly higher decay heat loads based on Residual Heat Removal (RHR) system heat loads shortly after shutdown. By the time the core is completely off-loaded (approximately 136 hours after shutdown), the RHR heat load is essentially zero. By increasing the flow of ERCW to the CCS heat exchanger to its maximum allowable flow, CCS maximum temperature can be decreased to values less than the 95°F design value, based on design ERCW temperature and design fouling of the CCS heat exchanger. Significant benefit can be obtained from this consideration during spring outages, as the ERCW temperature and resulting CCS temperatures are significantly less than design values.

Results of Alternate Analysis

By performing several analyses of SFP thermal performance at varying fouling factors from 0.0005 to 0.0001 and decreased CCS temperatures, a series of curves have been developed to provide operator guidance for an increase in allowable SFP decay heat. An analysis was performed for the limiting case of single train operation, in which the allowable design heat load was increased up to a maximum without exceeding the maximum design SFP temperature. Final curves of allowable decay heat vs. CCS Temperature and SFP Heat exchanger fouling were developed which included margin to account for inaccuracy inherent in reading graphs, and to add additional modeling conservatism. To implement these changes, WBN's design change process requires procedures to be developed or existing procedures reviewed and revised, if necessary, to allow increased decay heat to be placed in the SFP based on actual values for CCS temperature and SFP heat exchanger fouling. The following is a tabulation of specific SFP design values and parameters for both the existing design and the proposed alternate design:

WBN SPENT FUEL POOL DESIGN PARAMETERS

Parameter	Existing Design Value	Proposed Value (Alternate Analysis)
Maximum Allowable Decay Heat Load	32.6 MBTU/Hr	32.6 - 47.4 MBTU/Hr See Note 1.
SFPCCS Flow	2300 GPM per Hx	2300 GPM per Hx
CCS Flow	3000 GPM per Hx	3000 GPM per Hx
Allowable Tube Plugging	5 %	5 %
Tube-Side Fouling ($hr*ft^2*°F/Btu$)	0.0005	0.0005 - 0.0001
Shell-Side Fouling ($hr*ft^2*°F/Btu$)	0.0005	0.0005 - 0.0001
Maximum CCS Temperature	95°F	95 - 80°F (Note 1)
Maximum SFP Temperature (1-Train)	159.24°F	159.24°F
Maximum SFP Temperature (2-Train)	129.30°F	129.30°F
Average Time to SFP Boiling	5.24 Hours	3.4 Hours
Average SFP Heat-Up rate	10.2°F/Hr	15.54°F/Hr
Average Boil-Off Rate	70.20 GPM	102 GPM
Time until only 10 feet of water over racks - without makeup	43 Hours	29.8 Hours
Time until only 10 feet of water over racks - with 55 gpm makeup	200 Hours - Assuming constant decay heat. See Note 2	76 Hours
Margin to Localized Rack Boiling	9.6°F	6.8°F

Notes:

1. The range of values represent allowable heat loads based on specific combinations of heat exchanger fouling between 0.0005 and 0.0001 ($hr*ft^2*°F/Btu$) and actual CCS temperatures between 95 to 80°F.

2. If credit is taken for decreasing core decay heat energy during the 200 hour period, the 10 feet above rack level is never reached at a makeup rate of 55 GPM.

Impact of Higher Allowable Decay Heat in the SFP

As shown in the table above, the proposed change will not result in an increase in maximum SFP temperature. The only operational effect is noted during complete loss of both trains of cooling, whereby the higher allowable decay heat results in higher boil-off rates and faster required response times to mitigate the loss of SFP cooling event. The proposed values above, however, are comparable to existing values at Sequoyah Nuclear Plant, which was licensed for a higher allowable decay heat load during its rerack project.

An analysis has also been performed to evaluate the effect on localized temperatures within a spent fuel rack. The analysis was performed consistent with existing analysis methodologies except the rack and pool area were modeled using a three dimensional nodalization, instead of two dimensional. The inputs were revised to be consistent with the maximum allowable decay heat value (47.4 MBtu/hr). The results of the analysis show that while the margin to localized boiling has decreased, localized boiling within a rack will not occur. The analysis specifically concluded that:

1) the maximum local water temperature in the fuel storage racks was less than the local saturation temperature of the water, and

2) the bounding local fuel cladding temperature in the racks, determined by adding the bounding temperature difference between cladding material and water in the racks to the maximum local water temperature, was less than the local saturation temperature.

The increased heat load on CCS during single or dual train operation has minimal impact and is well within the design limits of the CCS system. Conservatism is maintained in the alternate analysis by ignoring all heat losses through concrete walls and SFPCCS piping, and ignoring both the mass of metal racks and fuel in the SFP and the mass of water in the transfer canal when determining the SFP heat capacity. The proposed change will not result in exceeding any system design limitation.

While existing design limits & operational procedures are adequate to prevent exceeding design limits on allowable SFP heat load, TVA proposes to revise the allowable heat loads. TVA proposes to increase the maximum allowable decay heat in the WBN SFP from 32.6 MBTU/Hr to a range between 32.6 MBTU/Hr and 47.4 MBTU/Hr. The lower value of 32.6 MBTU/Hr will only be exceeded if actual operating conditions of lower CCS temperature and/or lower than design fouling is present. Specific curves relating CCS Temperature and SFP heat exchanger fouling to allowable SFP decay heat have been developed to assist Operations in evaluating allowable SFP decay heat for each core off-loading evolution. These higher values of allowable decay heat within the SFP will not result in exceeding the analyzed maximum SFP temperature under normal full core off-load conditions (two train operation) of

129.3°F, and a faulted maximum temperature (one train operation) of 159.2°F. As described in Enclosure 2, TVA is seeking a licensing change to its SFPCCS allowable heat loads to allow use of actual fouling factors and CCS temperature in lieu of design values.

SFPCCS Summary

The SFPCCS has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. Without this change in methodology, existing SFPCCS operational parameters can accommodate Tritium Production operations by delaying the start of off-loading the core until design allowable heat loads can accommodate core and residual decay heat. The SFPCCS system can also accommodate the additional SFP heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with other design guidance regarding SFP heat exchanger fouling and CCS temperature. Tritium production activities will not have an adverse impact on the SFPCCS heat removal capabilities.

1.5.12 Component Cooling Water System

NUREG-1672, Section 2.9.4, "Because more fuel and TPBAR assemblies are removed from the core to the spent fuel pool during refueling, the maximum pool temperature will increase. Although the effect of the TPBARs on the CCWS is insignificant because the heat load generated by the TPBARs only amounts to about 3 watts per rod 150 hours after reactor shutdown, a substantial increase in heat load occurs as a result of a full core off-load. The additional heat load generated by the TPC to the spent fuel pool heat exchangers could increase the demand for CCWS flow. DOE stated that the system heat transfer and flow requirements may be affected by the TPBARs from the increase in spent fuel pool heat load during cooldown operations, and the effect on this system will need to be analyzed on a plant-specific basis. In response to the staff's RAI, DOE also stated that the increased spent fuel pool heat load does not come from the presence of TPBARs but from the increased number of fuel assemblies being replaced. The staff has identified this as an interface item that must be addressed by a licensee referencing the TPC topical report in its plant-specific application for authorization to irradiate TPBARs for the production of tritium."

Response

The design basis functions of the CCS include providing an intermediate cooling loop for heat removal from several safety related radioactive system heat exchangers, as well as several non-safety related components. Two of the highest heat loads placed on the CCS include the SFPCCS and the RHRS. These two decay heat systems are the primary means for cooling the plant and removing residual decay heat during later stages of plant cooldown and during outages.

Tritium Impact on Spent Fuel Pool Decay Heat

TVA has prepared a quantitative analysis of expected spent fuel decay heat for both Tritium Production Core (TPC) and non-TPC cores. The analysis is based on comparative decay heat data prepared by TVA for a base non-tritium core, a TPC with 80 fresh fuel assembles (80-feed), and a TPC with 96 fresh fuel assemblies (96-feed). The results of the analysis show that the 80 feed case was limiting for decay heat, and the 80-feed TPC core contributes a slightly higher decay heat over the non-TPC and the 96-feed TPC, due to isotopic composition differences between the base and TPC cores, for the same design basis reactor power level. The results of the analysis show that the 96-feed case was limiting for residual heat. The TVA analysis has quantified the actual TPC impact on core heat loads at approximately 0.3 MWt (approximately 1MBTU/HR), which included both the decay heat generated by freshly discharged fuel assemblies during a refueling outage, and the additional residual decay heat from the increased discharge rate (96 per outage) of fuel assemblies into the pool. This value is based on conservative, full pool SFP conditions.

Increased Spent Fuel Pool Cooling Heat Rejection on CCS

The design basis analysis for the CCS was evaluated for impact by the increased heat load from the SFPCCS. The increased SFPCCS heat load will not result in any significant temperature increase on CCS. The increase in decay heat associated with TPC is approximately 1 MBTU/Hr. This decay heat load increase is approximately 1% of the total design heat load on the CCS. The higher proposed increase in allowable decay heat load in the SFP, however, is comprised of both TPC related decay heat increase, plus additional margin to allow commencement of core off loading activities as early as 100 hours after shutdown. The proposed increase in decay heat above the approximate 1 MBTU/Hr associated with TPC, is a CCS heat load that is shifted from the RHRS to the SFPCCS. The shifting results from the fact that fuel is either in the core being cooled by RHRS, or it is in the SFP being cooled by the SFPCCS, both systems ultimately rejecting their respective heat burdens on the CCS.

CCS design thermal analysis have been evaluated and determined to be capable of accepting the increased SFPCCS allowable decay heat loads. CCS flows to the SFPCCS heat exchangers have not been increased. The additional heat load rejected to the CCS from the SFPCCS heat exchanger results in slightly elevated CCS temperatures, but is within existing design basis values. Piping analysis and support analysis of the CCS have been previously analyzed at a higher ultimate temperature associated with more bounding operational modes, and are not affected by the increased CCS heat load. The downstream dilution effect also helps to minimize the impact of the elevated CCS temperatures, since as SFPCCS heat loads increase, the RHRS heat loads decrease. With all CCS flows returning to a common header prior to returning to the CCS/ERCW heat exchangers, there is no measurable change to the mixed stream CCS temperature.

Since higher allowable SFP decay heat can be placed in the SFP if CCS temperatures and/or SFP heat exchanger fouling factors are shown to be less than design, maintaining the CCS temperature during outages to as low as possible is desired. CCS temperatures can be lowered considerably if ERCW flows to the CCS heat exchangers are increased. Increased ERCW flow rates are within existing flow criteria established for other modes of operations.

The CCS has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. The CCS system can also accommodate the additional SFP heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with other design guidance regarding SFP heat exchanger fouling and CCS temperature. Tritium production activities will not have an adverse impact on the CCS heat removal capabilities. Additional information on SFP decay heat is provided in Section 1.5.11.

CCS Summary

The Component Cooling System has adequate capacity and cooling margin to perform its safety and non-safety functions with the additional heat loads imposed by tritium production activities. Without this change in methodology, existing SFPCCS operational parameters can accommodate Tritium Production operations by delaying the start of off-loading the core until design allowable heat loads can accommodate core and residual decay heat. The CCS system can also accommodate the additional SFP heat loads imposed by the proposed change to allow commencement of core off-loads as early as 100 hours, consistent with other design guidance regarding SFP heat exchanger fouling and CCS temperature. Tritium production activities will not have an adverse impact on the CCS heat removal capabilities.