June 23, 2006

TVA-BFN-TS-431
TVA-BFN-TS-418

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop OWFN, P1-35
Washington, D. C. 20555-0001

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
	)	50-296

BROWNS FERRY NUCLEAR PLANT (BFN) – UNITS 1, 2, AND 3 - TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 – EXTENDED POWER UPRATE (EPU) - REVISED RESPONSE TO NRC ROUND 2 REQUESTS FOR ADDITIONAL INFORMATION SPLB-A.1, SPLB-A.2, AND SPLB-A.3 - (TAC NOS. MC3812, MC3743, AND MC3744)

By letter dated April 13, 2006 (ADAMS Accession No. ML061040217), TVA submitted revised responses to NRC Round 2 requests for additional information (RAIs) regarding TVA’s applications for extended power uprate of BFN Units 1, 2 and 3. As stated in that letter, Item 3.1.2(5) of the supplemental reply to RAIs SPLB-A.1, SPLB-A.2, and SPLB-A.3 was not complete at that time. The enclosure to this letter provides the completed response to the subject RAIs. The response provided is the same for all three BFN units.

If you have any questions regarding this letter, please contact me at (256)729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 23rd day of June, 2006.

Sincerely,

Original signed by:

William D. Crouch
Manager of Licensing
and Industry Affairs

Enclosure:

Supplement to Response to NRC Round 2 Requests for Additional Information - SPLB-A.1, SPLB-A.2, and SPLB-A.3

cc: (see page 3)

Enclosure
cc (w/Enclosure):

State Health Officer
Alabama Dept. of Public Health
RSA Tower - Administration
Suite 1552
P.O. Box 303017
Montgomery, AL 36130-3017

U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-3415

Malcolm T. Widmann, Branch Chief
U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303-8931

NRC Senior Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611-6970

NRC Unit 1 Restart Senior Resident Inspector
Browns Ferry Nuclear Plant
10833 Shaw Road
Athens, Alabama 35611-6970

Margaret Chernoff, Project Manager
U.S. Nuclear Regulatory Commission
(MS 08G9)
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

Ms. Eva A. Brown, Project Manager
U.S. Nuclear Regulatory Commission
(MS 08G9)
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852-2739

DTL:LTG:BAB
cc (w/o Enclosure):
B. M. Aukland, POB 2C-BFN
M. Bajestani, NAB 1A-BFN
A. S. Bhatnagar, LP 6A-C
J. C. Fornicola, LP 6A-C
R. G. Jones, POB 2C-BFN
G. V. Little, NAB 1A-C
R. F. Marks, Jr., PAB 1C-BFN
G. W. Morris, LP 4G-C
B. J. O'Grady, PAB 1E-BFN
K. W. Singer, LP 6A-C
E. J. Vigluicci, ET 11A-K
NSRB Support, LP 5M-C
EDMS WT CA-K, w.

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ENCLOSURE
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGE NOS. TS-418 AND TS-431 – SUPPLEMENT TO RESPONSE TO NRC ROUND 2 REQUESTS FOR ADDITIONAL INFORMATION – SPLB-A.1, SPLB-A.2, AND SPLB-A.3

By letter dated April 13, 2006 (ADAMS Accession No. ML061040217), TVA submitted revised responses to NRC Round 2 requests for additional information (RAIs) regarding TVA's applications for extended power uprate of BFN Units 1, 2 and 3. As stated in that letter, Item 3.1.2(5) of the supplemental reply to RAIs SPLB-A.1, SPLB-A.2, and SPLB-A.3 was not complete at that time. This enclosure provides the completed response to the subject RAIs. The response is the same for all three BFN units. The entire response to these RAIs is provided below for completeness; however, only the response to Item 3.1.2(5) has been revised and is marked by revision bar in the page margin.

NRC Request SPLB-A.1

Section 10.5.5 of the Updated Final Safety Analysis Report (UFSAR), Revision 17 dated August 30, 1999, revised the discussion from the UFSAR that was previously provided regarding the maximum SFP heat load for batch and full core offloads. In order to facilitate NRC review of the capability of the SFPCCS to perform its function for EPU conditions, provide a discussion on the safety-related systems required to maintain fuel pool cooling within design bases temperature limits.

NRC Request SPLB-A.2

For EPU conditions, explain how the SFP water temperature will be maintained below 150 degrees Fahrenheit (F) for the worst-case normal (batch) and full core offload scenarios assuming a loss of offsite power and (for the batch offload only) a concurrent single active failure considering all possible initial configurations that can exist. Include a description of the maximum decay heat load that will exist in the SFP for each case, how these heat loads were determined, such that they represent the worst-case conditions, and what the cooling capacity is for the systems that are credited, including how this determination was made. Also:

a. Describe any operator actions that are required, how long it will take to complete these actions, and how this determination was made; and

b. Describe the maximum core decay heat load that will exist at the onset of fuel movement, how this determination was made, how this heat load will be accommodated while also satisfying the SFP cooling requirements over the duration of the respective fuel offload scenarios, and including the situation where the SFP is isolated from the reactor vessel cavity.

NRC Request SPLB-A.3

Discuss how adequate SFP makeup capability is assured for EPU conditions in the unlikely event of a complete loss of SFP cooling capability, including how the maximum possible SFP boil-off rate compares with the assured makeup capability that exists, operator actions that must be taken, how long it will take to complete these actions and how this determination was made, and boron dilution considerations.

TVA's Supplemental Reply to SPLB-A.1, 2, and 3

TVA has previously provided information regarding the spent fuel pool cooling system at BFN and the effects of EPU in PUSAR Section 6.3 and in the December 19, 2005, reply to questions SPLB-A.1, SPLB-A.2, and SPLB-A.3. Additional discussion was provided in the April 13, 2006 letter to clarify and provide supplemental information on the BFN spent fuel pool cooling system and was presented in the format (including numbering) of Attachment 2 to Matrix 5 of RS-001, "Review Standard for Extended Power Uprates," Revision 0, December 2003.

At the time of the April 13, 2006 letter, information was not available to complete the response to Item 3.1.2(5). The following discussion provides the remaining information. Revisions to the previous response dated April 13, 2006 are marked with revision bars.

1. BACKGROUND

   The BFN fuel pool cooling and cleanup systems for Units 1, 2, and 3 are described in UFSAR Section 10.5. The systems cool the fuel storage pools by transferring the spent fuel decay heat through heat exchangers to the reactor building closed cooling water (RBCCW) systems. The system for each fuel pool consists of two circulating pumps connected in parallel, two heat exchangers, one filter demineralizer subsystem, two skimmer surge tanks, and the required piping, valves, and instrumentation. Four filter demineralizers are provided including one spare filter demineralizer shared between the three units. The pumps circulate the pool water in a closed loop, taking suction from the surge tanks, circulating the water through the heat exchangers and filter demineralizer, and discharging it through diffusers at the bottom of the fuel pool and reactor well (as required during refueling operations). The water flows from the pool surface through skimmer weirs and scuppers (wave suppressers) to the surge tanks.

The heat exchangers in the residual heat removal (RHR) system can be used in conjunction with the fuel pool cooling and cleanup system to supplement pool cooling (supplemental fuel pool cooling). Normal makeup water for the fuel pool cooling system is transferred from the condensate storage tank to the skimmer surge tanks. A seismic Class I qualified source of makeup water is provided through the crosstie between the RHR system and fuel pool cooling system. If necessary, the intertie between the RHR service water (RHRSW) system and the RHR system can be utilized to admit raw water as makeup. Also, a standpipe and hose connection is provided on each of the two emergency equipment cooling water (EECW) system headers which provide two additional fuel pool water makeup sources.

Additionally, the auxiliary decay heat removal (ADHR) system provides another means to remove decay heat and residual heat from the spent fuel pool and reactor cavity of BFN Units 2 and 3 and is described in UFSAR Section 10.22. As part of restart activities for BFN Unit 1, the ADHR system will be extended to include the spent fuel pool and reactor cavity of BFN Unit 1. During operation of this system, it is aligned to only one unit at a time. The ADHR system consists of two cooling water loops. The primary cooling loop circulates spent fuel pool water entirely inside the Reactor Building and rejects heat to a secondary loop by means of a heat exchanger. The secondary loop transfers heat to the atmosphere outside the Reactor Building by means of evaporative cooling towers.

Spent fuel pool cooling, including supplemental fuel pool cooling and ADHR, are non-safety systems. To ensure adequate makeup under all normal and off normal conditions, the RHR/RHRSW connection provides a permanently installed seismic Class I qualified makeup water source for the spent fuel pool. This ensures that irradiated fuel is maintained submerged in water and that reestablishment of normal fuel pool water level is possible under all anticipated conditions. Two additional sources of spent fuel pool water makeup are provided via a standpipe and hose connection on each of the two EECW headers. Each hose is capable of supplying makeup water in sufficient quantity to maintain fuel pool water level under conditions of no fuel pool cooling.

2. ACCEPTANCE CRITERIA

The current design and operational basis for BFN spent fuel pool cooling system is as follows:

- Administrative controls are used to ensure that the fuel pool heat load does not exceed available cooling capacity.
- The capacity of the spent fuel pool cooling and the ADHR systems, considering seasonal cooling water temperatures and current heat exchanger conditions, are utilized to maintain the fuel pool temperature at or below 125°F during normal refueling outages (average spent fuel batch discharged from the equilibrium fuel cycle).
- The RHR system can be operated in parallel with the spent fuel pool cooling system to maintain the fuel pool temperature less than the Technical Requirements Manual (TRM) limit of 150°F if a full core off load is performed. Plant instructions require that actions be taken well before exceeding this limit. The fuel pool temperature is normally maintained between 72°F and 125°F.
- To ensure adequate makeup under all normal and off normal conditions (i.e. fuel pool water boil off), the RHR/RHRSW crosstie provides a permanently installed seismic Class I qualified makeup water source for the spent fuel pool.
- Two additional sources of spent fuel pool water makeup are provided via a standpipe and hose connection on each of the two EECW headers. Each hose is capable of supplying makeup water in sufficient quantity to maintain fuel pool water level under conditions of no fuel pool cooling.

The design basis for the fuel pool cooling systems remains the same for the current and EPU conditions.

3. REVIEW PROCEDURES

3.1 Adequate SFP Cooling Capacity

To demonstrate adequate SFP cooling capacity, BFN performs both bounding and cycle-specific calculations. The bounding calculations have been reperformed for EPU conditions as described below in Section 3.1.1 to ensure that the acceptance criteria will continue to be met. Additionally, as described in Section 3.1.2, cycle-specific calculations are performed to assess cooling system capability to ensure that fuel pool heat load does not exceed available cooling capacity. These calculations demonstrate that the acceptance criteria described in Section 2 will continue to be met under EPU conditions.

As a result of EPU, the normal spent fuel pool heat load will be higher than the pre-EPU heat load. EPU will result in higher decay heat in the discharged bundles to the spent fuel pool as well as an increase in the number of discharged fuel bundles at the end of each cycle. The heat removal capability of the spent fuel pool cooling system, the ADHR system, or the supplemental fuel pool cooling mode of the RHR system are not affected by EPU. The evaluations for spent fuel pool cooling, as discussed below, include the effects from EPU operation and provide the results indicating that the design basis for the spent fuel pool will be maintained.

3.1.1 Bounding Calculation

Consistent with the BFN design basis, two cases were analyzed: 1. Partial core offload with operation of the spent fuel pool cooling system and ADHR system, and 2. Full core offload with operation of the spent fuel pool cooling system and RHR supplemental fuel pool cooling mode. In each case the initial fuel pool temperature was assumed to be 100°F.

1. Partial Core Offload

   The capacity of the fuel pool cooling system and the ADHR system to maintain the fuel pool temperature at or below 125°F during partial core offloads was evaluated for EPU conditions.

   The maximum decay heat loadings for the spent fuel pool were calculated using the ANSI/ANS 5.1-1979 Standard with two-sigma uncertainty. The heat load in the spent fuel pool is the sum of previous fuel offloads and the recent batch decay heats at the time of transfer. In this analysis, the offload consists of a batch of 332 fuel bundles offloaded to an almost full spent fuel pool. This batch size was chosen for analytical purposes; the actual batch size may vary.

   The spent fuel pool was assumed to be previously loaded with 2375 bundles allowing a reserve space for a full core offload (764 cells). The 2375 bundles were assumed to have been offloaded in eight batches, discharged at 24 month intervals. For this case, core offload begins 50 hours after reactor shutdown. Fuel transfer time was estimated based on a transfer rate of 14 bundles per hour to the fuel pool. These decay heat and offload time estimates establish the limiting case maximum heat loads.

Cooling of the fuel pool conservatively assumes that only one heat exchanger/pump combination is available for each system. The heat exchanger effectiveness is based upon original design specifications including standard value fouling factors and tube plugging criteria. The evaluation only considers the mass of water in the fuel pool and assumes no circulation of water between the fuel pool and the cavity for the period of time that fuel pool gates are open while the fuel is being transferred to the pool.

The results of this evaluation show that the peak spent fuel pool temperature remains less than 125°F under EPU conditions.

Table 1
Partial Core Offload Evaluation Results for One Train Each of Spent Fuel Pool Cooling System and ADHR[1]

Conditions/Parameters	Value
Peak spent fuel pool temperature (°F)	99.1
Time to peak spent fuel pool temperature (hours)	80
Time to boil from loss of all cooling at peak temperature (hours)	14
Boil off rate (gpm)	48

[1] Assumes core offload begins 50 hours after reactor shutdown to allow for cooldown, vessel head removal, refueling cavity filling, and other refueling preparations.

PUSAR Table 6-3 contains an additional case where a partial core offload was evaluated for one train each of the spent fuel pool cooling system and RHR supplemental fuel pool cooling mode. In that evaluation, the calculated peak spent fuel pool temperature of 124.9°F was less than 125°F.

Table 2
Partial Core Offload Evaluation Results for One Train Each of Spent Fuel Pool Cooling System and RHR Supplemental Fuel Pool Cooling Mode[1]

Conditions/Parameters	Value
Peak spent fuel pool temperature (°F)	124.9
Time to peak spent fuel pool temperature (hours)	130
Time to boil from loss of all cooling at peak temperature (hours)	13
Boil off rate (gpm)	42
[1] Assumes core offload begins 95 hours after reactor shutdown and includes 45 hours of invessel stay time because the RHR supplemental fuel pool cooling mode has less heat removal capacity than the ADHR.	

2. Full Core Offload

The capacity of the spent fuel pool cooling system and the RHR supplemental fuel pool cooling mode to maintain the fuel pool temperature at or below 150°F during a full core off load is evaluated for EPU conditions.

The maximum decay heat loadings for the spent fuel pool were calculated using the ANSI/ANS 5.1-1979 Standard with two-sigma uncertainty. The heat load in the spent fuel pool is the sum of previous fuel offloads and the recent full core decay heats at the time of transfer. The pool is assumed to be previously loaded with 2707 bundles. The prior offload batches were assumed to be the same as the partial core offload case above with an additional batch of 332 fuel assemblies having been discharged from the reactor core, all of which has been cooled for an additional 24 months. (The partial offload batch size was chosen for analytical purposes; the actual may vary.) The initiation of fuel offloading was a minimum of 50 hours after plant shutdown based upon shutdown cooling requirements, head removal time and refueling preparation. Actual times were determined based on the calculated heat removal capacity of the cooling mode. For this case, core offload begins 165 hours after reactor shutdown and includes 115 hours of invessel stay time because the RHR supplemental fuel pool cooling mode has less heat removal capacity than the ADHR system. Fuel transfer time was estimated based on a transfer rate of 14 bundles per hour to the fuel pool. These decay heat and offload time estimates establish the limiting case maximum heat loads.

Cooling of the fuel pool conservatively assumes that only one heat exchanger/pump combination is available for each system. The heat exchanger effectiveness is based upon original design specifications including standard value fouling factors and tube plugging criteria. The evaluation only considers the mass of water in the fuel pool and assumes no circulation of water between the fuel pool and the cavity for the period of time that fuel pool gates are open while the fuel is being transferred to the pool.

The results of this evaluation show that the peak spent fuel pool temperature remains less than 150°F under EPU conditions.

Table 3

Full Core Offload Evaluation Results for One Train Each of Spent Fuel Pool Cooling System and RHR Supplemental Fuel Pool Cooling Mode[1]

Conditions/Parameters	Value
Peak spent fuel pool temperature (°F)	149.8
Time to peak spent fuel pool temperature (hours)	229
Time to boil from loss of all cooling at peak temperature (hours)	4
Boil off rate (gpm)	80

[1] Assumes core offload begins 165 hours after reactor shutdown and includes 115 hours of invessel stay time because the RHR supplemental fuel pool cooling mode has less heat removal capacity than the ADHR.

PUSAR Table 6-3 contains an additional case where a full core offload was evaluated for one train each of the spent fuel pool cooling system and ADHR system. In that evaluation, the calculated peak spent fuel pool temperature of 121.5°F was also less than 150°F.

Table 4
Full Core Offload Evaluation Results for One Train Each of Spent Fuel Pool Cooling System and ADHR[1]

Conditions/Parameters	Value
Peak spent fuel pool temperature (°F)	121.5
Time to peak spent fuel pool temperature (hours)	109
Time to boil from loss of all cooling at peak temperature (hours)	5
Boil off rate (gpm)	104

[1] Assumes core offload begins 50 hours after reactor shutdown to allow for cooldown, vessel head removal, refueling cavity filling, and other refueling preparations.

3.1.2 Cycle-Specific Calculation

Unloading the reactor core and the associated increase in fuel pool heat load is a controlled evolution. Administrative controls are used to ensure that the fuel pool heat load does not exceed available cooling capacity, such that the fuel pool gates are not closed until the decay heat load is less than or equal to the fuel pool cooling heat exchanger capacity. Performance of the fuel pool cooling systems is predicted prior to each refueling outage as part of the Outage Risk Assessment Review (ORAM) process.

In addition to the following discussion, BFN is taking additional actions to further augment procedures pertaining to the cycle specific administrative controls. Procedure changes will be generated (1) to define and control the generation of cycle-specific fuel pool heat load calculations, and (2) to control the installation of the fuel pool gates based on the calculated fuel pool heat load.

Cycle-specific analysis conditions:

(1) Predicted decay heat for both the spent fuel pool and reactor core are determined by utilizing a TVA code (DHEAT) that complies with the methods of ANSI/ANS 5.1. The history of previous fuel discharges is used as input into the decay heat load determination for the spent fuel pool. The decay heat results are best-

estimate values and are provided for a range of decay times that may be needed for the spent fuel pool evaluations.

(2) Cooling system heat removal is calculated utilizing a spreadsheet based on heat balances of the affected systems. Fuel pool cooling capacity of the systems is based upon inlet cooling temperatures, system flow rates, trains in service, and heat exchanger performance values.

(3) As described in (2) above, heat removal capabilities are determined for each of the BFN cooling trains, including the normal spent fuel pool cooling system, the ADHR system, and the supplemental fuel pool cooling mode of RHR.

(4) The limiting parameter for heat load and heat removal capability is the insertion of the fuel pool gates following core offload. When the fuel pool gates are removed and spent fuel movement begins, additional cooling is provided by the shutdown cooling system that provides decay heat removal directly to the reactor vessel. Evaluations of the spent fuel pool temperature following discharge of the partial core offload are performed based on cooling system configurations to ensure that the spent fuel pool temperature can be maintained without the additional heat removal capacity of the shutdown cooling system.

(5) Calculations of spent fuel pool heat load and heat removal capability as described herein are premised with maintaining the spent fuel pool temperature within the Technical Requirements Manual (TRM) 3.9.2 limit of $\leq$ 150°F based on limited equipment availability. Additionally, plant instructions require that actions be taken well before exceeding this value.

The spent fuel pool structure will accommodate boiling conditions in the case of a complete loss of spent fuel pool cooling. In this case, adequate make-up supply is available as described in Section 3.2 below

(6) Administrative controls are provided as part of ORAM to ensure that appropriate controls are provided for shutdown safety. These controls ensure proper assessment of key shutdown areas (i.e., reactivity control, shutdown cooling, AC power, fuel pool cooling, etc.). Spent fuel pool cooling assessments

are performed prior to the outage and updated during the outage to ensure appropriate controls are maintained for the safe operation of spent fuel pool cooling.

3.2 Adequate Make-Up Supply

The evaluations described in Sections 3.1.1.1 and 3.1.1.2 above are used to determine the time to boil for make-up capability. These evaluations assume only one train of each cooling system is in operation to determine the peak spent fuel pool temperature. At the time of peak spent fuel pool temperature, it is assumed that all spent fuel pool cooling is lost. Based on decay heat, the time to reach boiling conditions is then calculated. The results are provided in Tables 1 through 4 above.

The minimum time to reach boiling is four hours based on the case presented in Table 3. This case involves a full core offload and assumed loss of all cooling at the peak spent fuel pool temperature of 149.8°F. The associated boil off rate is 80 gpm.

The maximum boil off rate is 104 gpm based on the case presented in Table 4. This case involves a full core offload and assumed loss of all cooling at the peak spent fuel pool temperature of 121.5°F. The associated time to reach boiling is five hours.

For BFN the RHR/RHRSW crosstie provides a permanently installed seismic Class I qualified makeup water source for the spent fuel pool. This supply can be aligned within the minimum four hours calculated above and can supply greater than 150 gpm to the spent fuel pool.

Two additional sources of spent fuel pool water makeup are provided via a standpipe and hose connection on each of the two EECW headers. Each hose is capable of supplying makeup water at 150 gpm to the spent fuel pool within the minimum four hours calculated above.