Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-14-200

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10 CFR 50.4

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

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Revised Response to Request for Additional Information Related to Potential Loss of Spent Fuel Pool Cooling – NRC RAI 1**

References:

1. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2 and 3 - Request for Additional Information Related to Potential Loss of Spent Fuel Pool Cooling (TAC No. ME6761)," dated March 24, 2014 (ML14055A295)

2. Letter from TVA to NRC, "Response to NRC Request for Additional Information Related to Potential Loss of Spent Fuel Cooling," dated September 3, 2014 (ML14248A681)

In Reference 1, the Nuclear Regulatory Commission (NRC) staff stated that an initial evaluation of a petition request concerning the reliability of the Spent Fuel Pool (SFP) cooling systems was complete. Using information contained in each subject facility's safety analysis report, the NRC staff concluded that additional information was necessary from certain facilities in order to evaluate the response of the facilities following design-basis events.

The staff selected facilities that shared a common secondary containment surrounding two SFPs for its initial information request. The NRC stated that these facilities were more likely to have a high decay heat load due to refueling in one of the SFPs, during a time when other equipment within the secondary containment may be essential for accident mitigation or safe shutdown of an adjacent operating unit.

The NRC requested that in order to better understand the reliability of the SFP cooling systems, the expected response of the affected facilities to their loss, and the safety significance of the SFP cooling function at the Browns Ferry Nuclear Plant (BFN), that the Tennessee Valley Authority (TVA) respond to the request for additional information provided.

In Reference 2, TVA provided a response to NRC RAI 1 through NRC RAI 4. TVA has since determined that the NRC RAI 1 response, describing the availability of the Residual Heat Removal (RHR) System in supporting Fuel Storage Pool cooling, requires clarification.

TVA's revised response to NRC RAI 1 is provided in the enclosed information. The changes to RAI 1 are identified by revision bars in the right margin. TVA's response to NRC RAIs 2, 3, and 4 remain as provided in Reference 2.

There are no new regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact Edward D. Schrull at (423) 751-3850.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure: Revised Response to Request for Additional Information Related to Potential Loss of Spent Fuel Pool Cooling – NRC RAI 1

cc (w/ Enclosure):

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant
State Health Officer - Alabama Department of Public Health

Revised Response to Browns Ferry Nuclear Plant, Units 1, 2 and 3 - Request for Additional Information Related to Potential Loss of Spent Fuel Pool Cooling – NRC RAI 1

Please respond to the following RAIs for the requested facility. The performance of structures, systems, and components should consider standard accident analysis methods and assumptions used in the safety analysis report, including loss of function under conditions beyond those considered in the design of the structure, system, or component (SSC) and consideration of additional single failures. Operator actions may be included when the action is specified in existing operating, alarm response, or emergency procedure and the personnel expected to execute the action have been properly trained.

NRC RAI 1

Describe the ability to maintain forced cooling of the spent fuel pool (SFP) using installed equipment following a design-basis earthquake with consequential loss of offsite power. Please consider SFP configurations encountered during routine refueling and normal operating conditions. The normal SFP cooling system and the SFP cooling assist mode of the residual heat removal system should be considered at a minimum, and, if a sustained loss of forced SFP cooling is expected, identify the expected range of times for the pool to reach saturation conditions.

Tennessee Valley Authority (TVA) Response

<u>Introduction</u>

At the Browns Ferry Nuclear Plant (BFN), the structure referred to as the Spent Fuel Pool (SFP) is called the Fuel Storage Pool (FSP). Also, the system referred to as the Spent Fuel Pool Cooling (SFPC) system at BFN is called the Fuel Pool Cooling (FPC) system. These terms were used interchangeably in past TVA correspondence with the NRC designating the same structure or system.

Under standard accident analysis methods and assumptions used in the Final Safety Analysis Report (FSAR), structures, systems, and components (SSCs) designed to Seismic Class I would perform their safety function following a Design Basis Earthquake (DBE). Seismic Class I includes those SSCs whose failure or malfunction might cause, or increase the severity of an accident which could endanger the public health and safety. This category includes those SSCs required for safe shutdown and isolation of the reactor.

SSCs designed to Seismic Class II are important to reactor operation, but are not essential for preventing an accident that could endanger the public health and safety, and are not essential for the mitigation of the consequences of such accidents. BFN Seismic Class II SSCs qualified for pressure boundary integrity are qualified to maintain pressure boundary integrity before, during, and after a seismic event at the site.

<u>Ability to Provide Forced Cooling to the FSP</u>

During normal operation, forced cooling to the FSP is provided by the FPC system that circulates FSP water through heat exchangers cooled by the Reactor Building Closed Cooling Water (RBCCW) system. The Auxiliary Decay Heat Removal (ADHR) system is also capable of providing forced cooling to the FSP. The ADHR system primary loop contains heat exchangers that are cooled by the ADHR secondary loop cooling towers. In addition, the Residual Heat Removal (RHR) system can be lined up to provide forced cooling to the FSP in the assist mode of operation by circulating FSP water through the RHR heat exchangers cooled by the Residual Heat Removal Service Water (RHRSW) system.

The entire FPC and ADHR systems have not been qualified to remain functional following a DBE, i.e., they are not Seismic Class I. Therefore, under standard accident analysis methods and assumptions used in the FSAR, these systems are not credited for forced cooling of the FSP.

The RHR/RHRSW systems and the portion of the FPC system that provides make-up water to the FSP are qualified to Seismic Class I requirements. Under standard accident analysis methods and assumptions used in the FSAR, the RHR/RHRSW systems can be credited for providing raw make-up water to the FSP by utilizing piping from the RHR system and FPC system. Also, the RHR/RHRSW systems are powered from the emergency diesel generators (EDGs) so they would remain functional when offsite power is not available, i.e., following a loss of offsite power (LOOP).

The suction flow path from the FSP to the RHR pumps includes a portion of the FPC system that is Seismic Class II, which is qualified for pressure boundary integrity. As such, this portion of the FPC system can not be credited for providing FSP water to the RHR pumps. Therefore, the RHR system cannot be credited for forced cooling of the FSP under standard accident analysis methods and assumptions used in the FSAR.

The Unit 2 FPC system that forms part of the flow path to the suctions of the RHR pumps has been evaluated to Seismic Class I design requirements but it is not considered Seismic Class I in the FSAR. As such, there is reasonable assurance that this piping would remain functional following a DBE. The portions of the Unit 1 FPC system and the Unit 3 FPC system that forms part of the flow path to the suctions of the RHR pumps is similar in configuration to the Unit 2 piping configurations. This similarity provides reasonable assurance that the Unit 1 and Unit 3 piping system would also remain functional following a DBE.

Provided the portion of the FPC system that forms part of the flow path to the suctions of the RHR pumps remains usable following a DBE, site procedures provide for the alignment of the RHR system to the FSP cooling assist mode of operation. In addition, the physical condition of the reactor building and contained SSCs following a DBE would allow operators to access the manually operated equipment necessary to put RHR into the FSP cooling mode of operation.

As described in the FSAR, there are two RHR Loops per Unit. Each loop has two Pumps and two Heat Exchangers. Each Unit has the ability to share one RHR Loop with the adjacent unit(s). Each RHR heat exchanger is cooled by the RHRSW system. The RHRSW system has eight shared pumps. There are eight EDGs that can power all the components in these systems needed for the required RHR pumps and heat exchangers to be functional. Under standard accident analysis methods and assumptions used in the FSAR, one RHR Loop is required for safe shutdown when each reactor has been in power operation. Due to the high interconnectivity of the RHR/RHRSW and onsite power systems, it is likely that for any station configuration and single failure, at least one RHR Loop would be available to maintain each reactor in safe shutdown.

As discussed above, following a DBE, it is possible that only equipment which is designed to Seismic Class I requirements would be available to shut down the reactor and mitigate the consequences of an accident. Portions of the FPC systems, although assessed as Seismic Class I, were not licensed as Seismic Class I. Therefore, under standard accident analysis methods and assumptions as described in the FSAR, neither the FPC system nor the RHR fuel pool cooling assist mode are considered available to provide FSP forced cooling. Seismic Class II components may not be available, thus the loss of forced cooling of the FSP would ultimately result in the pool reaching saturation conditions. Additionally, the concurrent LOOP for this event would require that all three units be in cold shutdown (Mode 4) within 37 hours of the LOOP. However, under standard accident analysis methods and assumptions described in the FSAR, Mode 4 (cold shutdown) may not be achieved because the safety function of the shutdown cooling valves is to close or stay closed. Using these assumptions, the reactor would stay in Mode 3 (hot shutdown), which allows one loop of the RHR System to be used to maintain the reactor in Mode 3 and a separate loop of RHR to provide makeup water to the FSP via the fuel pool cooling assist mode.

If the shutdown cooling suction flow path from the reactor vessel to the RHR pumps is able to be used, the reactor would proceed to Mode 4. In Mode 4, the shutdown cooling mode of RHR is required by Technical Specifications to be in service. However, due to the common flow paths of the shutdown cooling and fuel pool cooling assist modes of RHR, these functions could not be placed in service simultaneously except in Mode 5 with the water level greater than 22 feet above the top of the RPV flange and the fuel pool gates out. Therefore, another Seismic Class I source of makeup water to the FSP must be used during Mode 4.

As identified in FSAR Section 10.5.5, the RHRSW system is available to provide an adequate, permanently-installed Seismic Class I qualified FSP makeup water source under all normal and off normal conditions (i.e., fuel pool water boil off). Additional Seismic Class I sources of makeup water are also available utilizing a standpipe and hose connection on each of two Emergency Equipment Cooling Water (EECW) System headers, either of which have sufficient capacity for the FSP makeup water requirement. This diversity of Seismic Class I FSP makeup water sources ensures that irradiated fuel remains submerged in water and that normal fuel pool water level is possible under all anticipated conditions.

<u>Minimum Time to FSP Boiling</u>

Based on the above discussion for the plant response to a DBE with consequential LOOP under standard accident analysis methods and assumptions used in the FSAR, forced cooling of the FSP cannot be assured. However, makeup water would be provided to the FSP using Seismic Category I equipment. To the extent that forced cooling of the FSP cannot be assured under the strict FSAR assumptions, TVA has evaluated the time for the water in the FSP to boil following a DBE with consequential LOOP.

The minimum time to FSP boiling would occur just after the reactor has been refueled and the gates to the FSP have been closed. In this plant configuration and at this point in a refueling outage, there would be the least volume of water available in the FSP to absorb the heat released from the stored fuel and this would be when the FSP has the highest heat load due to the recently irradiated and discharged fuel. In this plant configuration and at this point in a refueling outage, the minimum time to FSP boiling would be more than twelve hours. However, twelve hours would be sufficient time to identify a loss of FSP cooling and align the RHR/RHRSW systems to provide makeup water to the FSP. All other plant configurations before, during, or after a refueling outage would have more than this minimum time to FSP boiling. In the FSPs that have not just been loaded with recently irradiated fuel, the time to FSP boiling would be about 40 hours.

In summary, if the reactor were to experience a DBE with consequential LOOP and under standard accident analysis methods and assumptions used in the FSAR:

- Forced cooling of the FSP would not be available;
- For all plant configurations and times prior to, during, or after a refueling outage, the minimum time for the FSP to start to boil after a loss of forced FSP cooling would be twelve hours; and
- Make-up water to the FSP would be available to keep the fuel covered.

However, due to the design and construction of the return FPC piping, the time available before FSP boiling would occur, and the diversity of alternative FSP Seismic Class I makeup sources as discussed above, there is reasonable assurance of the ability to maintain FSP inventory and cooling (e.g., via feed and bleed strategies) following a DBE with consequential LOOP.