May 6, 2004

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

Gentlemen:

In the Matter of	)	Docket No. 50-259
Tennessee Valley Authority	)	

BROWNS FERRY NUCLEAR PLANT (BFN) UNIT 1 – RESPONSE TO NRC GENERIC LETTER (GL) 97-04, ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD (NPSH) FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS

This letter provides TVA's response to NRC Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," for BFN Unit 1.

On October 7, 1997, NRC issued NRC Generic Letter 97-04 requesting that licensees review the current design-basis analyses used to determine the available NPSH for the emergency core cooling (including core spray and decay heat removal) and containment heat removal pumps. TVA responded to this Generic Letter for Units 2 and 3 in References 1-3. In Reference 1, TVA committed to address Generic Letter 97-04 for BFN Unit 1 prior to its restart. NRC closure of the Generic Letter for Units 2 and 3 is documented in Reference 4. The Enclosure provides TVA's response to Generic Letter 97-04 for BFN Unit 1.

TVA will request approval to credit containment overpressure as part of proposed Technical Specification 431, the BFN Unit 1 Extended Power Uprate application, which is scheduled for submission in June, 2004. Upon approval of the requested change, no additional information should be required to support closure of Generic Letter 97-04 for BFN Unit 1.

There are no new regulatory commitments associated with this submittal. If you have any questions about this submittal, please contact me at (256) 729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 6, 2004.

Sincerely,

Original signed by:

T. E. Abney
Manager of Licensing
and Industry Affairs

References:

1. TVA letter, T.E. Abney to NRC, "Browns Ferry Nuclear Plant (BFN) - Response to NRC Generic Letter (GL) 97-04, Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps," dated October 31, 1997.

2. TVA letter, T.E. Abney to NRC, "Browns Ferry Nuclear Plant (BFN) - Response to NRC Generic Letter (GL) 97-04, Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps," dated January 5, 1998.

3. TVA letter, T.E. Abney to NRC, "Browns Ferry Nuclear Plant (BFN) - Response to NRC Generic Letter (GL) 97-04, Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps," dated March 24, 1998.

4. NRC letter, A.W. DeAgazio to O.J. Zeringue, "Browns Ferry Nuclear Plant, Units 2 and 3 - Completion of Licensing Action for Generic Letter 97-04 (TAC Nos. M99964 AND M99965)," dated June 11, 1998.

cc: See Page 3

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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN) UNIT 1

RESPONSE TO NRC GENERIC LETTER 97-04
ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD
FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS

The purpose of this enclosure is to provide TVA's response to the requested information in NRC Generic Letter 97-04 for BFN Unit 1. The Generic Letter requests that TVA submit information necessary to confirm the adequacy of the net positive suction head (NPSH) available for emergency core cooling (including core spray and decay heat removal) and containment heat removal pumps. The request pertains to pumps that take suction from the suppression pool following a design basis loss of coolant accident (LOCA) or secondary line break or pumps used in operation that are necessary for recirculation cooling of the reactor core or containment.

BFN Unit 1 is currently licensed for a maximum rated thermal power of 3,293 MWt, but in an extended outage with extensive restart activities in progress. Prior to restart, TVA plans to seek approval under 10 CFR 50.90 to increase the maximum rated thermal power to 3,952 MWt. Therefore, the analyses discussed below have been performed assuming the uprated conditions.

Specific Requested Information and TVA's Response

NRC Request 1

Specify the general methodology used to calculate the head loss associated with the ECCS suction strainers.

TVA Response

The net positive suction head available ($NPSH_A$) at the pump suction nozzles is a function of the system configuration, system pressures, flow rates, elevation differences, and other head losses. The following provides a description of the BFN Emergency Core Cooling Systems (ECCS) and summarizes the $NPSH_A$ analysis.

ECCS DESCRIPTION

The Browns Ferry ECCS configuration includes an ECCS ring header circumscribing the suppression chamber with connecting piping to four inlet penetrations through the torus wall into the suppression chamber. Inside the suppression chamber, each connecting line is fitted with a flanged surface for mating to the ECCS strainer flanges. The ECCS ring header is the normal suction source for the low pressure Residual Heat Removal (RHR) and Core Spray (CS) System pumps and the alternate suction source for the High Pressure Core Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) System pumps. The normal suction path for the HPCI and RCIC System pumps is the Condensate Storage Tank. The HPCI and RCIC systems are only used short term during a large break LOCA; and therefore, are not considered critical to long term NPSH considerations.

The four strainers direct ECCS flow to a common ring header. The common ring header supplies water to two loops of RHR (2 pumps per loop) and 2 loops of CS (2 pumps per loop). The range of suppression pool temperatures for design basis events is 95°F (the BFN Unit 1 Ultimate Heat Sink limit) to a maximum temperature of 187°F.

The original plant design included four, 1/8 inch mesh cylindrical strainers. As described in additional detail in TVA's response to NRC Bulletin 96-03, Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors (Reference 1), TVA is installing new high capacity strainers in Unit 1.

NET POSITIVE SUCTION HEAD ANALYSIS

The $NPSH_A$ is defined as:

$$NPSH_A = h_a + h_s - h_{vp} - h_f$$

where

h_a = air space absolute pressure (in feet of water) in the suppression chamber on the surface of the water.

h_s = static (i.e., elevation difference) suction pressure (in feet of water) between the water surface in the suppression chamber and the ECCS pump suction nozzle. Positive quantities represent a water surface above the pump nozzle. The suppression chamber water level is based on Technical Specification 3.6.2.2, the minimum level value with zero pressure differential between the drywell and suppression chamber.

h_{vp} = vapor pressure (i.e., saturation pressure of water) (in feet of water) at the bulk temperature of the suppression pool. Since the water temperature changes during the course of an accident, this parameter is a function of time as discussed in the response to NRC Request 2 below.

h_f = pressure drop (in feet of water) due to the piping system configuration and condition. Additional discussion of this term is provided below.

The pressure drop due to the piping system configuration and condition is based upon the limiting RHR/CS loop considering piping length/configuration, flow components and suction strainers.

The assumed piping length is conservatively based on the loop with the longest length from the suction strainer inside the suppression chamber to the pump nozzle. However, an analysis of the ring header flow demonstrates that the flow will actually originate approximately equally from each of the four strainers (dependent on differential blockage). Assuming the flow comes from only the nearest strainer maximizes the frictional pressure drop due to the higher flow rate in that ring header section.

The pressure drop analysis considers the number and type of piping components (e.g., elbows, tees, valves, etc.) present in the line and utilizes standard pressure drop methods and values. Entrance losses for the suction strainer in addition to the pressure drop associated with strainer blockage are included in the analysis. The ECCS is filled with demineralized condensate quality water; thus, no pipe aging is included. Consequently, clean commercial steel pipe for the determination of friction losses is assumed. An informal sensitivity study was performed with friction factors higher than those used for clean pipe. The results indicated the potential increase in line losses to be insignificant.

The analyses performed in response to NRC Bulletin 96-03 utilized the BWR Owners Group (BWROG) Utility Resolution Guidance (URG) methodology for the determination of debris loading on the high capacity strainers and then determined the $NPSH_A$ versus $NPSH_R$ using the theoretical piping system pressure drop methods described above. The discussion of the debris loading is detailed in Reference 1.

The analysis supporting Unit 1 utilizes an h_a in excess of atmospheric pressure. The existence of the containment overpressure for the applicable events was verified by containment pressure analyses using assumptions to conservatively minimize the containment pressure during a DBA-LOCA.

NRC Request 2

Identify the required NPSH and the available NPSH.

TVA Response

The $NPSH_R$ versus the $NPSH_A$ for the RHR and CS systems are shown in Table 1 for the revised analysis, assuming debris loadings developed in response to NRC Bulletin 96-03, the upgraded ECCS suction strainer design, credit for containment overpressure, and Extended Power Uprate conditions. The following provides a discussion of the basis for the values in the analysis.

TVA's limiting short term analysis assumes that the flow of two RHR pumps is being directed into a broken recirculation loop and subsequently to the drywell. Flow from the other two pumps is being injected into the unbroken recirculation loop and subsequently into the reactor vessel.

During the first 10 minutes of the LOCA event, all automatic RHR and CS pump starts are assumed to occur and operate with a total design flow rate of 54,500 gpm across the ECCS strainers. To maximize strainer flow, it is assumed in the analysis that at initial pump start, 2 RHR pumps (one loop) are at runout flow (11,000 gpm per pump), 2 RHR pumps (one loop) are at design flow (10,000 gpm per pump), and 4 CS pumps (two loops) are at design flow (3,125 gpm per pump). The RHR system has flow limiting orifices in the pump discharge lines that limit the runout flow to 11,000 gpm.

The long term limiting containment analysis (after the first ten minutes of the LOCA event) models a double-ended recirculation suction line break with no offsite power and the failure of one emergency diesel generator. TVA calculations, which are consistent with the BFN Emergency Operating Instructions (EOIs)[1], assume that at ten minutes into the DBA-LOCA, manual operator actions secure ECCS pumps not required for core cooling and align

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1. The BFN Unit 1 EOIs are currently under development; when developed, they are expected to be identical to the BFN Units 2 and 3 EOIs with regard to operation of the low pressure core cooling systems.

RHR into the suppression pool cooling mode. The BFN EOIs, which are symptom based, require establishing long term cooling requirements upon reaching a preset reactor vessel level. During simulator scenarios, actions to establish long term cooling occur prior to ten minutes. Hence, the assumptions made in DBA-LOCA analysis for $NPSH_A$ are validated through simulator scenarios. The minimum long term flow required for accident analyses is 2 RHR pumps on one loop at design flow in the containment cooling mode (6,500 gpm per pump) and 2 CS pumps at design flow providing injection to the reactor pressure vessel (3,125 gpm per pump) for a total flow of 19,250 gpm.

The $NPSH_R$ is based on the pump manufacturer's data for both the RHR and CS system pumps. The $NPSH_R$ is specific to each pump type and is dependent upon the flow rate being evaluated. The $NPSH_A$ is dependent on the number of pumps operating and their flow rate, piping system configuration and condition (as described above), and the suppression pool temperature (vapor pressure) at the containment conditions being evaluated. The analyses is based on suction strainer debris loadings developed using the BWROG URG methodology, an upgraded suction strainer design, Extended Power Uprate conditions (operation at 3952 MWt) and a credit of 3 psig for containment overpressure. The results of this analysis are provided in Table 1. The vapor pressure of the water and the pump/flow conditions in the analyses are based on the conditions shown in Table 1.

NRC Request 3

Specify whether the current design basis NPSH analysis differs from the most recent analysis reviewed and approved by the NRC for which a safety analysis has been issued.

TVA Response

The most recent BFN Unit 1 design basis NPSH analysis reviewed and approved by the NRC is described in a June 28, 1974, letter from the Atomic Energy Agency issuing Amendment 3 to the BFN Unit 1 Operating License (Reference 2). That amendment, in part, authorized increasing the maximum suppression pool temperature from 90°F to 95°F. The associated Safety Evaluation concluded adequate NPSH for CS and RHR could be maintained with no dependency on containment overpressure.

The previous BFN Unit 1 NPSH analysis was based on:

- Original licensed thermal power (3293 MWt);
- Original ECCS suction strainer design;
- Pre-NRC Bulletin 96-03 debris loading assumptions; and
- No credit for containment overpressure.

As discussed above, the BFN Unit 1 ECCS NPSH analysis developed to support restart is based on:

- Extended Power Uprate Conditions (3952 MWt);
- Upgraded ECCS suction strainer design;
- Debris loading assumptions developed in response to NRC Bulletin 96-03; and
- A containment overpressure credit of 3 psig.

TVA will request NRC approval of the containment overpressure credit as part of the BFN Unit 1 Extended Power Uprate application.

NRC Request 4

Specify whether containment overpressure (i.e., containment pressure above the vapor pressure of the sump or suppression pool fluid) was credited in the calculation of available NPSH. Specify the amount of overpressure needed and the minimum overpressure available.

TVA Response

The current licensing basis for BFN Unit 1 does not credit containment pressure above the vapor pressure of the suppression pool in the calculation for available NPSH. However, TVA's upgraded design and conservative analyses developed in response to NRC Bulletin 96-03 require credit for containment pressure in excess of the atmospheric pressure to meet RHR and CS pump NPSH requirements. Table 1 provides the BFN Unit 1 required and available RHR and CS pump NPSH based on NRC Bulletin 96-03 resolution, Extended Power Uprate conditions, and assuming a 3 psig credit for containment overpressure.

NRC Request 5

When containment overpressure is credited in the calculation of available NPSH, confirm that an appropriate containment pressure analysis was done to establish the minimum containment pressure.

TVA Response

The current licensing basis NPSH calculation does not take credit for available containment overpressure. As described in TVA's response to Bulletin 96-03, containment overpressure will be required to be utilized to resolve the Bulletin. A minimum overpressure analysis was performed to ensure adequate overpressure exists when credit for overpressure is needed. Details of that analysis will be submitted in the BFN Unit 1 Extended Power Uprate amendment request.

References:

1. TVA letter to NRC, dated July 25, 1997, "Browns Ferry Nuclear Plant (BFN) - NRC Bulletin 96-03, Potential Plugging of Emergency Core Cooling Suction (ECCS) Strainers by Debris in Boiling-Water Reactors (TAC NOS. M96135, M96136, M96137)."

2. Letter to TVA from the United States Atomic Energy Commission, dated June 28, 1974, Amendment 3 to The BFN license No. DPR-33 for Browns Ferry Nuclear Plant Unit 1.

TABLE 1

RHR AND CORE SPRAY PUMP NPSH CASES[1]

	RHR PUMP FLOW CONDITION	RHR PUMP FLOW RATE	RHR PUMP NPSH REQUIRED (FEET)	RHR PUMP NPSH AVAILABLE (FEET)	CORE SPRAY PUMP FLOW CONDITION	CORE SPRAY PUMP FLOW RATE	CS PUMP NPSH REQUIRED (FEET)	CS PUMP NPSH AVAILABLE (FEET)
Initial ECCS Start-Maximum flow in one RHR loop and design flow in other RHR and CS loops. Suppression Pool @ 95°F	2 pumps on one loop @ runout and 2 pumps on one loop @ design flow (in LPCI Mode)	11,000 gpm (x2) 22,000 gpm plus 10,000 gpm (x2) 20,000 gpm Total Flow 42,000 gpm	29	39.09	2 pumps on each loop @ design flow	3,125 gpm (x4) 12,500 gpm	27	42.81
Within First 10 minutes, LPCI maximum flow in one RHR Loop, CS at normal design flow. Suppression Pool @ 155.4°F	2 pumps on one loop @ runout and 2 pumps on one loop @ design flow (in LPCI Mode)	11,000 gpm (x2) 22,000 gpm plus 10,000 gpm (x2) 20,000 gpm Total Flow 42,000 gpm	29	31.00	2 pumps on each loop @ design flow	3125 GPM (x4) 12,500 GPM	27	35.00
Long Term ECCS pump flows at peak torus temperatures 186.6°F	2 pumps on one loop at design flow (Containment cooling)	6,500 gpm (x2) 13,000 gpm	24	32.78	2 pumps on one loop at design flow	3125 gpm (x2) 6250 gpm	27	29.46

1. Assumes Extended Power Uprate conditions (3952 MWt), upgraded ECCS suction strainer design, debris loading conditions developed in response to NRC Bulletin 96-03, and a credit for 3 psig containment overpressure.