TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

December 22, 1997

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

10 CFR 50.54(f)

Gentlemen:

In the Matter of	)	Docket Nos.	50-327 50-390
Tennessee Valley Authority	)		50-328

SEQUOYAH NUCLEAR PLANT (SQN) AND WATTS BAR NUCLEAR PLANT (WBN) 90-DAY RESPONSE TO NRC GENERIC LETTER (GL) 97-04, "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS," DATED OCTOBER 7, 1997

This letter provides TVA's 90-day response for SQN Units 1 and 2 and WBN Unit 1 to the subject GL which requested information pertaining to the amount of suction head available to certain safety system pumps. In accordance with the GL, and TVA's commitment made in our 30-day response, TVA has performed the requested actions for SQN and WBN and summarized the results in Enclosures 1 and 2, respectively. The response for Browns Ferry Nuclear Plant is being provided separately.

TVA participated in the December 2, 1997, workshop on the GL and used the industry guidance in developing this response. Our involvement in industry activities and our review of design calculations have demonstrated that SQN and WBN have ample margin available.

A001/1

If you have questions regarding this response, please contact Everett Whitaker at (423) 751-6369.

Sincerely,

Mark J. Burzynski

Mark J. Burzynski
Manager
Nuclear Licensing

Subscribed and sworn to before me
this 22nd day of December 1997

Gemalee Petty
Notary Public

My Commission Expires March 21, 2001

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cc: Continued on page 3

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)

RESPONSE TO NRC GENERIC LETTER (GL) 97-04, "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS," DATED OCTOBER 7, 1997

NRC Request

1. Specify the general methodology used to calculate the head loss associated with the emergency core cooling system (ECCS) suction strainers.

Response

The basic methodology used for determining pump net positive suction head (NPSH) involves a comparison of the difference between the total available suction head (absolute head measured at the pump impeller eye) and the vapor head (absolute) of the pumped fluid. This basic methodology is reflected in the following equation:

$$NPSH = h_a - h_{vpa} + h_{st} - h_{fs}$$

where:

h_a = atmospheric head, absolute pressure (in feet of liquid) on the surface of the liquid being pumped.

h_{vpa} = vapor head, the head in feet corresponding to the vapor pressure of liquid at the temperature being pumped.

h_{st} = static head, static height in feet that the liquid supply level is above the pump impeller eye.

h_{fs} = friction head, all suction line losses (in feet) including all sump screen and form losses as well as friction losses through piping, valves and fittings.

In applying this basic relationship to the Sequoyah ECCS and containment spray pumps for the sump recirculation mode, the following conservative methodologies and assumptions were used to establish each term:

h_a - Absolute pressure on the surface of the liquid supply level.

This term is defined as the product of the containment pressure and the specific volume of the liquid being pumped. The Sequoyah calculations assume that the containment pressure is atmospheric (14.7 psia). This assumption is consistent with NRC Regulatory Guide 1.1 which states that no credit is to be taken for post-accident containment pressurization. The specific volume of the sump fluid is conservatively assumed to be that of water at 190°F. The assumed 190°F water temperature represents the maximum post-accident sump fluid temperature.

h_{vpa} - Vapor pressure of liquid at the temperature being pumped.

This term is defined as the product of the saturation pressure for the temperature of the liquid being pumped and the specific volume of the liquid at that temperature. The Sequoyah calculations conservatively assume that the saturation pressure and specific volume of the sump fluid is that of water at 190°F. The assumed 190°F water temperature represents the maximum post-accident sump fluid temperature.

h_{st} - Static height of the pumped fluid above the pump impeller eye.

This term is defined as the elevational difference between the surface level of the fluid being pumped and the center of the pump impeller eye. The Sequoyah calculations use the difference between the calculated containment sump level during recirculation and the ECCS and containment spray pump suction elevation for the static head. Containment sump levels are assumed to be conservatively low for both large break (LBLOCA) and small break (SBLOCA) loss-of-coolant accidents. Calculations which use methodologies and assumptions which minimize sump level have been performed for both accidents to confirm that the assumed containment sump levels are less than the calculated minimum sump levels.

h_{fs} = Friction head losses (in feet) in the suction line including friction losses through piping, valves and fittings as well as sump screen and form losses.

This term is defined as the head loss due to flow resistance encountered by the pumped fluid in the pump suction line. The Sequoyah calculations maximize the friction head loss by the conservative calculation and summation of the following parameters:

1. Sump screen and form losses which address head losses from the sump inlet screen to the residual heat removal and containment spray pump suction piping. This value was empirically established for Sequoyah based on scale model testing performed prior to plant operation. The testing measured pressure head losses for the actual sump configuration and established a corresponding loss coefficient for the sump configuration. The loss coefficient relates actual sump screen, form and suction piping entrance head losses to the fluid velocity in the pump suction piping. These losses were calculated for conservatively high pump flow rates. (These calculated losses assume that the sump screen is free from blockage. Sump screen blockage has been evaluated separately as described in the response to Item 2.)

2. Suction line friction losses which consider the piping length, size (schedule), relative roughness, fitting resistance (i.e., piping elbows, reducers, tee connections, gate valves and check valves) and fluid velocity. The Sequoyah calculations establish an equivalent pipe length for the actual length of straight pipe and all associated fittings and valves in the ECCS and containment spray pump suction piping. The maximum established equivalent piping length is combined with conservatively high pump flow rates, actual pipe inside diameters and an empirically determined friction factor to establish bounding suction line friction losses.

NRC Request

2. Identify the required NPSH and the available NPSH.

Response

The following is a summary of the available NPSH and the required NPSH for the Sequoyah ECCS pumps.

Pump	Available NPSH	Required NPSH	Excess NPSH
Residual Heat Removal (LBLOCA)	33.96 ft	24.70 ft	9.26 ft
Containment Spray (LBLOCA)	26.04 ft	14.11 ft	11.93 ft
Residual Heat Removal (SBLOCA) (No Containment Spray)	39.79 ft	14.00 ft	25.79 ft
Residual Heat Removal (SBLOCA) (With Containment Spray)	31.93 ft	14.00 ft	17.93 ft
Containment Spray (SBLOCA)	19.35 ft	14.11 ft	5.24 ft
Safety Injection (LOCA) (Hot Leg Recirculation)	55.32 ft	27.00 ft	28.32 ft
Safety Injection (LOCA) (Cold Leg Recirculation)	61.10 ft	27.00 ft	34.10 ft
Centrifugal Charging (LOCA) (Hot Leg Recirculation)	55.10 ft	23.00 ft	32.10 ft
Centrifugal Charging (LOCA) (Cold Leg Recirculation)	58.10 ft	23.00 ft	35.10 ft

During the containment sump recirculation mode of operation, the Sequoyah residual heat removal pumps and containment spray pumps take suction from the containment sump. The safety injection pumps and the high pressure centrifugal charging pumps take suction from the residual heat removal pump discharge. As indicated above, available NPSH has been evaluated for the residual heat removal pumps and the containment spray pumps when aligned to the containment sump. The available NPSH has also been evaluated for the safety injection and high pressure centrifugal charging pumps when aligned to the residual heat removal pump discharge. No other Sequoyah ECCS pumps take suction from the containment sump or are supplied by pumps which take suction from the containment sump during the sump recirculation mode of operation.

Since there are significant differences between ECCS pump functional requirements and containment sump levels for the LBLOCA and SBLOCA recirculation mode of operation, the available NPSH has been evaluated for both accident conditions for the pumps directly aligned to the containment sump. Additionally, since the size and location of a SBLOCA will determine if the containment spray system will be activated, an evaluation of the available SBLOCA recirculation mode NPSH has been performed with and without actuation of the containment spray system for the pumps which take suction directly from the containment sump.

The safety injection pumps and high pressure centrifugal charging pumps have similar flow requirements for both the large break and small break loss-of-coolant accidents. A single evaluation has been performed for both accidents when the pumps are operating aligned to the residual heat removal pump discharge piping. Since there are slight differences in the safety injection and centrifugal charging pump flow distributions between reactor coolant system cold leg injection and hot leg injection, the available NPSH for the safety injection and centrifugal charging pumps has been evaluated for injection into both the reactor coolant system hot legs and cold legs.

The available NPSH values for the residual heat removal and containment spray pumps were established using the methodology described in the response to Item 1. The available NPSH values for the safety injection and centrifugal charging pumps were calculated in a similar manner with output from a hydraulic model of the Sequoyah ECCS which conservatively establishes the pump suction pressure based upon operation of a single residual heat removal pump.

The required NPSH for each pump was established from the equipment manufacturer's performance test curve for the required flow rate. The difference between the residual heat removal pump required NPSH for LBLOCA and SBLOCA conditions is based upon the different pump performance requirements. For a LBLOCA, the reactor coolant system pressure decreases below the pump shutoff head and a conservatively large residual heat removal pump flow is assumed. For a SBLOCA, the reactor coolant system pressure remains above the pump shutoff head and no hot leg or cold leg injection flow is provided by the residual heat removal pumps.

The available NPSH values listed above assume that the sump screen is free from post-accident debris blockage. A separate evaluation of head losses associated with sump screen blockage has been performed. The evaluation uses an empirical relationship which establishes sump screen head loss as a function of fluid velocity, sump screen mesh size and an empirical discharge coefficient established for rectangular mesh screens. This relationship was benchmarked for the Sequoyah sump configuration by comparison of predicted head losses to actual head losses measured during scale model testing for clean sump screens (no blockage) and 50% screen blockage. The evaluation established that with both trains of residual heat removal and containment spray pumps in operation at conservatively high flow rates, the increase in sump screen head loss from 0% screen blockage to 90% screen blockage would be 2.40 ft for a LBLOCA and 1.16 ft for a SBLOCA. Given the excess NPSH values listed above and the results of a containment debris transport study which confirms that less than 90% screen blockage will occur under accident conditions, adequate NPSH is available to address worst case sump screen blockage.

<u>NRC Request</u>

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 evaluation was issued.

<u>Response</u>

The original NRC approval of the available NPSH calculations for Sequoyah ECCS operation is documented in the initial plant safety evaluation report (Section 6.3.3 of NUREG-0011, including Supplements 1 and 2). Since the issuance of the initial plant safety evaluation report, the design-basis NPSH calculations have been upgraded as part of the 1986-1987 Design Calculation Program performed in accordance with the Sequoyah Nuclear Performance Plan. Under the calculation upgrade program, the original calculations were given a general revision to include a clear purpose, verifiable input assumptions, uniform methodologies and clear acceptance criteria. The revised calculations were classified as "essential" and were subjected to an independent review to establish technical adequacy. While the Design Calculation Program was evaluated by NRC and found to be acceptable in the Sequoyah Nuclear Performance Plan safety evaluation report (Section 2.3 of NUREG-1232, Volume 2), the revised NPSH calculations produced under the program were not specifically addressed by NRC.

The technical changes made to the available NPSH calculations during the calculation upgrade program involved the addition of conservatism to the assumed ECCS flow rates, the addition of conservatism to the assumed containment sump bulk fluid temperature, the refinement of the containment sump level calculations to reflect revised containment spray flow paths between upper and lower containment and the evaluation of containment sump screen blockage.

The changes made to add conservatism to the assumed ECCS flow rates and containment sump bulk temperature are consistent with the NRC evaluation in Section 6.3.3 of NUREG-0011, Supplement 1. The bulk containment sump temperature was increased from 160°F to 190°F to reflect the maximum expected temperature. The containment spray flow rate assumed in the analysis was increased to contain a level of conservatism similar to that cited for the residual heat removal pumps (i.e., a conservative flow rate above expected pump runout conditions).

The changes made to the sump level calculations for containment spray drainage were made to be consistent with the resolution of the "ECCS Water Loss Outside Crane Wall/Air Return Fan Operability" issue described in Section 3.9 of NUREG-1232, Volume 2. The containment sump level calculations were revised to reflect plant modifications performed in 1988-1989 designed to drain containment spray inventory diverted from the active sump back to the active sump.

The evaluation of sump screen blockage was performed in accordance with the resolution of the "Containment Coatings" issue described in Section 3.7 of NUREG-1232, Volume 2. The evaluation is described in the response to Item 2. The evaluation confirms that adequate ECCS pump NPSH is available for the maximum expected containment sump screen blockage under accident conditions.

Since the completion of the calculation upgrade program, the available NPSH calculations have been revised to reflect a 1991 modification to the containment spray system. The assumed containment spray flow rate was conservatively increased from 5,700 gpm to 6,211 gpm as part of a design change which evaluated system operation with a higher head containment spray pump rotating element.

In summary, the current design-basis NPSH analysis differs from the analysis reviewed and approved by the NRC as part of the original plant safety evaluation. The majority of the changes made to the analysis were performed as part of the Sequoyah Nuclear Performance Plan to address issues evaluated by the NRC safety evaluation contained in NUREG-1232, Volume 2. The balance of the changes were performed to support a plant modification which was evaluated under 10 CFR 50.59 criteria. The current design-basis analysis continues to meet the requirements of NRC Regulatory Guide 1.1 for consideration of sump bulk temperature and containment pressure.

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.

Response

The ECCS and containment heat removal systems at Sequoyah are designed such that adequate NPSH is provided assuming the maximum expected sump fluid temperature (190°F) and no increase in the assumed containment pressure (atmospheric or 14.7 psia) subsequent to a postulated loss-of-coolant accident. No credit is taken for containment overpressure in the calculation of available NPSH.

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.

Response

Since containment overpressure is not credited in the calculation of available NPSH, this question is not applicable to Sequoyah.

<u>Source Documents</u>

The following documents were reviewed to support the development of the Sequoyah response to NRC Generic Letter 97-04:

1. Calculation SQN-SQS4-0082, R4, "NPSH Calculation for the RHR and CSS Pumps Operating in the Recirculation Mode for a Large Break Loss-of-Coolant Accident", (B87 911120 012).

2. Calculation SQN-OSG7-0008, R4, "Containment Sump Minimum Level at Time of Switchover to Recirculation Mode for a Large Break Loss-of-Coolant Accident", (B45 880707 429).

3. Calculation SQN-72-D053 EPM-STM-060388, R4, "Containment Spray Pump Maximum Flow in the Recirculation Mode, Unit 1", (B87 970912 005).

4. Calculation SQN-72-D053 EPM-DLB-060587, R2, "Containment Spray Pump Maximum Flow in the Recirculation Mode, Unit 2", (B87 970213 015).

5. Calculation SQN-SQS4-0108, R3, "NPSH Calculation for the RHR and CSS Pumps Operating in the Recirculation Mode for a Small Break Loss-of-Coolant Accident", (B87 911113 014).

6. Calculation SQN-SQS4-0104, R3, "Determination of Minimum Level in Containment Sump at Time of Switchover to Recirculation Mode for a Small Break Loss-of-Coolant Accident", (B45 880726 426)

7. Norris Laboratory Report No. WM28-1-45-102, R0, "Model Study of the Sequoyah Residual Heat Removal Sump", dated October 1978 (B45 870622 251).

8. Westinghouse Topical Report No. WCAP-11534, R0, "Evaluation of Containment Coatings", dated September 1987 (B38 930503 801).

9. Westinghouse Letter TVA-97-133, "Available NPSH for the Sequoyah Safety Injection and Centrifugal Charging Pumps During Loss-of-Coolant Accident Recirculation Mode of Operation", dated December 1997 (B38 971211 802).

10. NRC NUREG-0011, "Safety Evaluation Report for the Sequoyah Nuclear Plant Units 1 and 2", Page 6-29.

11. NRC NUREG-0011, Supplement 1, "Safety Evaluation Report for the Sequoyah Nuclear Plant Units 1 and 2", Pages 6-7 and 6-8.

12. NRC NUREG-0011, Supplement 2, "Safety Evaluation Report for the Sequoyah Nuclear Plant Units 1 and 2", Pages 6-5 through 6-7.

13. NRC NUREG-1232, Volume 2, "Safety Evaluation Report for the Sequoyah Unit 2 Nuclear Performance Plan", Pages 2-10 through 2-13, Pages 3-62 through 3-64 and Pages 3-67 through 3-69.

14. NRC NUREG-1232, Volume 2, Supplement 1, "Safety Evaluation Report for the Sequoyah Unit 1 Nuclear Performance Plan", Pages 2-6 and 2-7 and Pages 3-14 and 3-15.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
Unit 1

RESPONSE TO NRC GENERIC LETTER (GL) 97-04, "ASSURANCE OF SUFFICIENT NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL PUMPS," DATED OCTOBER 7, 1997

NRC Request

1. Specify the general methodology used to calculate the head loss associated with the emergency core cooling system (ECCS) suction strainers.

Response

The basic methodology used for determining pump net positive suction head (NPSH) involves a comparison of the difference between the total available suction head (absolute head measured at the pump impeller eye) and the vapor head (absolute) of the pumped fluid. This basic methodology is reflected in the following equation:

$$NPSH = h_a - h_{vpa} + h_{st} - h_{fs}$$

where:

h_a = atmospheric head, absolute pressure (in feet of liquid) on the surface of the liquid being pumped.

h_{vpa} = vapor head, the head in feet corresponding to the vapor pressure of liquid at the temperature being pumped.

h_{st} = static head, static height in feet that the liquid supply level is above the pump impeller eye.

h_{fs} = friction head, all suction line losses (in feet) including all sump screen and form losses as well as friction losses through piping, valves and fittings.

In applying this basic relationship to the Watts Bar ECCS and containment spray pumps for the sump recirculation mode, the following conservative methodologies and assumptions were used to establish each term:

h_a - Absolute pressure on the surface of the liquid supply level.

This term is defined as the product of the containment pressure and the specific volume of the liquid being pumped. The Watts Bar calculations assume that the containment pressure is atmospheric. This assumption is consistent with NRC Regulatory Guide 1.1 which states that no credit is to be taken for post-accident containment pressurization. The specific volume of the sump fluid is conservatively assumed to be that of water at 190°F. The assumed 190°F water temperature represents the maximum post-accident sump fluid temperature.

h_{vpa} - Vapor pressure of liquid at the temperature being pumped.

This term is defined as the product of the saturation pressure for the temperature of the liquid being pumped and the specific volume of the liquid at that temperature. The Watts Bar calculations conservatively assume that the saturation pressure and specific volume of the sump fluid is that of water at 190°F. The assumed 190°F water temperature represents the maximum post-accident sump fluid temperature.

h_{st} - Static height of the pumped fluid above the pump impeller eye.

This term is defined as the elevational difference between the surface level of the fluid being pumped and the center of the pump impeller eye. The Watts Bar calculations use the difference between the floor elevation of lower containment and the ECCS pump suction elevation for the static head. No credit is taken for collection of water that would result in containment sump level above the lower containment floor elevation. This conservative methodology has allowed the Watts Bar NPSH calculations to consider only the large break loss-of-coolant accident (LBLOCA) case and associated flowrates. NPSH calculations are not required to be performed for the small break loss-of-coolant accident (SBLOCA) because the maximized flowrates and minimized sump level used as input for the LBLOCA case envelope the SBLOCA case.

h_{fs} = Friction head losses (in feet) in the suction line including friction losses through piping, valves and fittings as well as sump screen losses.

This term is defined as the head loss due to flow resistance encountered by the pumped fluid in the pump suction line. The Watts Bar calculations maximize the friction head loss by the conservative calculation and summation of the following parameters:

1. Sump trashrack and screen head losses at the inlet to the ECCS suction piping. The Watts Bar containment sump is located within an 8 foot high passageway under the refueling canal. This portion of containment is an open, one level area with no drains used to route water to the sump. The water from a LOCA simply fills the floor area and covers the sump entrance. The annular shape of the containment area allows water to approach the sump inlet from two directions simultaneously, passing in both cases through vertical screened trashracks at the entrances to the passageway. The trashracks, which are the outer sump boundaries, extend approximately 16 ft from the reactor shield wall to the divider wall and approximately 8 ft from the floor to the ceiling, with one at each entrance to the passageway. The sump inlet is located in the floor between the two screened trashracks. Two ECCS entrance pipes which can be operated independently, exist at the lower elevation of the sump. A screen is also located in front of the two entrance pipes. The pressure loss coefficient for the screens is computed as a function of percent blocked using methods contained in the Journal, American Institute of Chemical Engineers, Vol. 14, May 1968 and as further investigated by the Tennessee Valley Authority's Norris Laboratory. The resulting pressure loss coefficients are then used to compute the head loss across the trashrack and entrance pipe screens as a function of percent blocked. The design basis transport analysis for unqualified containment coatings is based on 90% trashrack screen blockage. The internal screen at the ECCS entrance pipes can not be blocked since it has the same screen size as the outer trashracks and all the unqualified coatings inside the trashrack are on the floor and will be prevented from reaching the sump inlet by the 6 inch high curb that surrounds it. The head loss for 90% blockage of both the trashrack screens and the ECCS entrance pipe screen is conservatively used as input to the RHR pump NPSH calculations. The head loss value used as input to the containment spray pump NPSH calculations exceeds the sum of the head loss for 90% blockage of the trashrack screens and 0% blockage of the internal ECCS entrance pipe screen. Note that even 50% blockage of the internal ECCS screen would result in less than 1 inch reduction in the available NPSH for the containment spray pumps. The screen losses were calculated for conservatively high residual heat removal and containment spray pump flow rates.

2. Suction line friction losses which consider the piping length, size (schedule), relative roughness, fitting resistance (i.e., piping elbows, reducers, tee connections and gate valves) and fluid velocity. The Watts Bar calculations establish an equivalent pipe length for the actual length of straight pipe and all fittings and gate valves in the residual heat removal and containment spray suction piping. (There are no flow check valves in the residual heat removal or containment spray pump sump suction lines.) The equivalent piping length is combined with conservatively high pump flow rates, actual pipe inside diameters and an empirically determined friction factor to establish bounding suction line friction losses.

NRC Request

2. Identify the required NPSH and the available NPSH.

Response

The following is a summary of the available NPSH and the required NPSH for the Watts Bar ECCS and Containment Spray pumps.

Pump	Available NPSH	Required NPSH	Excess NPSH * (static hd excluded)	Excess NPSH * (static hd included)
Residual Heat Removal (LBLOCA) (with containment spray)	22.7 ft	21.0 ft	1.7 ft	10.2 ft
Containment Spray (LBLOCA) (with ECCS)	16.9 ft	13.2 ft	3.7 ft	12.2 ft

* When considering the specified excess NPSH, it should be noted that the design basis NPSH calculations of record conservatively assumed no credit for containment pressure above atmospheric, *took no credit for static water heights above the containment floor level*, and used the maximum reactor building fluid temperature. Therefore, excess NPSH values are also provided with the minimum LBLOCA lower containment water level included to demonstrate the actual excess available.

The tabular results provided above for the RHR and Containment Spray pumps are for the train having the least excess NPSH. During the containment sump recirculation mode of operation, the Watts Bar residual heat removal pumps and the containment spray pumps take suction from the containment sump. The safety injection pumps (SIPs) and the high pressure centrifugal charging pumps (CCPs) take suction from the residual heat removal pump discharge during the sump recirculation mode. Due to the significant suction boost provided to the SIPs and the CCPs during recirculation "piggyback" operation, NPSH is not a concern during this mode. Although NPSH data is not tabulated for piggyback operation of the SIPs and CCPs, NPSH analyses which have been performed for these pumps during the injection mode from the RWST are bounding for the piggyback mode, and they demonstrate that fully adequate NPSH is available. In addition, the results of the Sequoyah NPSH analyses performed for the recirculation mode are comparable to that which would exist for Watts Bar due to similarities in ECCS system operation, pump design, and pipe sizes and configuration. The tabulated Sequoyah results further demonstrate that fully adequate NPSH is available for the Watts Bar SIPs and CCPs during the sump recirculation mode.

The available NPSH for each case listed above was calculated using the methodology described in the response to Item 1, considering the effects of trashrack screen blockage at the maximum design value of 90%. The presented results are based on TVA prepared calculations for the containment spray pumps and Westinghouse prepared calculations for the ECCS pumps. As stated in the response to question 1, NPSH calculations are not required to be performed for the SBLOCA because the maximized flowrates and minimized sump level used as input for the LBLOCA case envelope the SBLOCA case.

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 evaluation was issued.

Response

The original NRC approval of the available NPSH calculations for Watts Bar ECCS operation is documented in the initial plant safety evaluation report (Section 6.3.2 of NUREG-0847). Since the issuance of the initial plant safety evaluation report, the design-basis NPSH calculations have been reperformed in accordance with the 1991-1993 Design Calculation Program. The Design Calculation Program was included within the Design Baseline and Verification Program CAP of the Watts Bar Nuclear Performance Plan. Under the calculation upgrade program, the containment spray pump NPSH calculations were given a general revision by TVA to include a clear purpose, verifiable input assumptions, uniform methodologies and clear acceptance criteria. The revised calculations were classified as "essential" and were subjected to an independent review to establish technical adequacy. The ECCS NPSH calculations were performed by Westinghouse in support of the Design Calculation Program in conjunction with analyses for related ECCS performance issues. The Westinghouse ECCS NPSH calculations were prepared to similar standards as the TVA prepared containment spray NPSH calculations. While the Design Calculation Program was evaluated by NRC and found to be acceptable in the Watts Bar Nuclear Performance Plan safety evaluation report (Section 3.2.3 of NUREG-1232, Volume 4), the revised ECCS and containment spray NPSH calculations produced under the program were not specifically addressed by the NRC. The results of the calculations are described in the Watts Bar Safety Analysis Report. NRC has documented their SAR reviews and approvals (through Amendment 91) in the Safety Evaluation Report and SER Supplements 1 through 20.

The primary technical differences between the available ECCS and containment spray NPSH calculations approved in the original SER and the current calculations involve the adjustment of pump flow rates to maximum design values (as confirmed by preoperational testing), the elimination of credit for containment sump level above the lower containment floor, and the adjustment of trashrack screen losses to correspond to the design basis blockage of 90%.

In summary, the current design-basis NPSH analysis differs from the analysis reviewed and approved by the NRC as part of the original plant safety evaluation. The changes made to the analysis were performed as part of the Watts Bar Performance Plan to address issues evaluated by NRC in NUREG-1232, Volume 4. No changes have been made to the NPSH calculations and no system changes have been made that could impact the NPSH calculations since receipt of the operating license. The current design-basis analysis continues to meet the requirements of NRC Regulatory Guide 1.1 for consideration of sump bulk temperature and containment pressure.

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.

Response

The ECCS and containment heat removal systems at Watts Bar are designed such that adequate NPSH is provided assuming the maximum expected sump fluid temperature (190°F) and no increase in the assumed containment pressure above atmospheric subsequent to a postulated loss-of-coolant accident. No credit is taken for containment overpressure in the calculation of available NPSH.

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.

Response

Since containment overpressure is not credited in the calculation of available NPSH, this question is not applicable to Watts Bar.

Source Documents

The following documents were reviewed to support the development of the Watts Bar response to NRC Generic Letter 97-04:

1. Calculation EPM-RCP-120291, R2, "Containment Spray Pump Net Positive Suction Head (NPSH) Calculation" (B26 950405 338)

2. Calculation WBN-OSG4-196, R4, "Transport Analysis for Containment Coatings" (B26 960602 394)

3. Westinghouse Letter WAT-D-9126, "ECCS NPSH Analysis" (T33 921201 949)

4. Westinghouse Letter WAT-D-9898, "RHR Pump NPSH Calculation" (T33 950106 818)

5. Westinghouse Letter WAT-D-10107, "ECCS Report" (T60 970918 867)

6. Norris Laboratory Report No. WM28-1-85-101, R0, "Model Study of the Watts Bar RHR Sump", dated March 1979 (B45 860813 252).

7. Norris Laboratory Report No. WM28-2-85-131, R0, "Effects of Blocked RHR Sump Screens on Trashrack Headloss, Net Positive Suction Head, and Vortexing Propensity at Watts Bar Nuclear Plant", dated July 1989 (B26 891017 205).

8. NRC NUREG-0847, "Safety Evaluation Report for the Watts Bar Nuclear Plant, Units 1 and 2", Page 6-15, and Pages 6-25 through 6-34.

9. TVA Letter to the NRC dated February 12, 1982 (A27 820212 016)

10. NRC NUREG-1232, Vol. 4, "Safety Evaluation Report for the Watts Bar Nuclear Performance Plan", Section 3.2.3