## WBN2Public Resource

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**Sent:** Monday, March 14, 2011 10:56 AM
**To:** Epperson, Dan; Poole, Justin; Raghavan, Rags; Milano, Patrick; Campbell, Stephen
**Cc:** Crouch, William D; Hamill, Carol L; Boyd, Desiree L; Beach, Charles D
**Subject:** TVA letter to NRC_03-11-11_Interim Response to GL 2008-01
**Attachments:** 03-11-11_Interim Response to GL 2008-01_Final.pdf

***Please see attached TVA letter that was sent to the NRC today.***

***Thank You,***

~*~*~*~*~*~*~*~*~*~*~*~*~*~*~

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Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

**Subject:** **WATTS BAR NUCLEAR PLANT (WBN) UNIT 2 –RESPONSE AFTER COMPLETION OF THE ENGINEERING FOR THE ECCS, RHR, AND CSS SYSTEMS IN UNIT 2 TO NRC GENERIC LETTER (GL) 2008-01: "MANAGING GAS ACCUMULATION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEMS"**

References:

1. TVA Letter to NRC dated October 1, 2008, Watts Bar Nuclear Plant (WBN) Unit 2 - Initial Response To NRC Generic Letter (GL) 2008-01: “Managing Gas Accumulation In Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems”
2. Unit 1 Letter from TVA to NRC dated January 14, 2011 Response to Request for Additional Information Regarding Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"
3. TVA Letter to NRC dated October 11, 2008 Browns Ferry Nuclear Plant (BFN) Units 1, 2 and 3, Sequoyah Nuclear Plant (SQN) Units 1 and 2, and Watts Bar Nuclear Plant (WBN) Unit 1 - 9 Month Response To NRC Generic Letter (GL) 2008-01: Managing Gas Accumulation In Emergency Core Cooling, Decay Heat Removal, And Containment Spray Systems,

The purpose of this letter is to provide a description of the design features and other considerations for WBN Unit 2 that will serve to preclude operability impacts due to the accumulation of gas in the subject systems based on the completion of engineering for those systems. This letter also provides the schedule for completing the actions, and the basis for that schedule. The information in this letter was requested of plants with an Operating License in GL 2008-01. This letter closes Commitment 1 from Reference 1 to provide this information. TVA will complete the modifications to support closure of this GL prior to fuel load. Reference 2 is an RAI response for Unit 1 on GL 2008-01. The corresponding Unit 2 information is included in Enclosure 2.

The NRC issued GL 2008-01 to request that each licensee evaluate the licensing basis, design, testing and corrective actions for the Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems to ensure gas accumulation is maintained less than the amount that challenges the operability of these systems.

Enclosure 1 provides a response consistent with the approach used by Unit 1 in Reference 3. Enclosure 2 provides Response to Request for Additional Information Regarding NRC Generic Letter 2008-01. Enclosure 3 provides the list of commitments made in this letter. If you have any questions, please contact William Crouch at (423) 365-2004.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

Enclosures:

1. WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems

2. Response to Request for Additional Information Regarding NRC Generic Letter 2008-01

3. List Of WBN-Specific Commitments

cc (Enclosures):

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## Enclosure 1

## WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems

This Enclosure describes the WBN Unit 2 design for the ECCS, RHR, and CSS systems and their conformance to the requirements of NRC Generic Letter (GL) 2008-01, Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems. TVA has confirmed that the information below accurately reflects Unit 2 and its associated documentation. The design of these systems are patterned after Unit 1 and considered both the original design and corrective actions taken on Unit 1 to address and manage gas accumulation. The Unit 2 design features for managing gas accumulation also considered the differences between the units.

The following information is provided in this response:

a) A description of the results of evaluations that were performed pursuant to the requested actions in the GL (see Section A of this Enclosure),
b) A description of physical or administrative measures to assure compliance with the quality assurance criteria in Sections II, V, XI, XVI, and XVII of Appendix B to 10 CFR Part 50, the licensing basis, and operating license with respect to the systems identified in the GL (see Section B of this Enclosure), and
c) A discussion of the actions that have been completed. A discussion of actions to be accomplished and a basis for the scheduled completion (see Section B).

The following systems were determined to be in the scope of GL 2008-01 for WBN:

- Emergency Core Cooling System
- Residual Heat Removal System (Generic term in the GL is Decay Heat Removal)
- Containment Spray Systems (WBN has the capability to provide containment spray from both the Containment Spray System and the RHR System)

## A. EVALUATION RESULTS

### <u>Licensing Basis Evaluation</u>

The WBN licensing basis was reviewed with respect to gas accumulation in the Emergency Core Cooling Systems, Residual Heat Removal System and Containment Spray System. This review included the Technical Specifications (TS), TS Bases, Final Safety Analysis Report (FSAR), the Technical Requirements Manual (TRM) and TRM Bases, responses to NRC Generic Communications, Regulatory Commitments, and License Conditions.

This review determined that the licensing basis for the ECCS, RHR System and Containment Spray System is that voiding in these systems is maintained at a level that does not significantly affect their performance when mitigating design basis accidents (DBAs) or while maintaining Safe Shutdown (SSD). This basis is consistent with the requirements of the GL.

Enclosure 1

**WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems**

## Design Evaluation

The WBN design basis was reviewed with respect to gas accumulation in the Emergency Core Cooling, Residual Heat Removal and Containment Spray Systems. This review included Design Basis Documents, Calculations, Engineering Evaluations, and Vendor Technical Manuals.

This review determined that the ECCS, RHR System and Containment Spray System design includes features that ensure pumps, pipe and components are maintained full of water. These features include:

- The pumps are located below their suction sources with no inverted U-turns in the suction pipe with the exception of CS pump 2A-A
- The level in the suction sources is monitored and minimum water levels have been established to ensure that unacceptable air ingestion does not occur during a DBA.
- The level instrumentation on suction sources is sloped to ensure it can be filled and vented.
- Suction pipe is at greater than atmospheric pressure during power operation.
- There are no significant sources of gas in suction pipe from the refueling water storage tank or from the containment sump.
- Periodic pump tests and/or normal system operation have a flow rate sufficient to sweep voids through most of the suction pipe.

In addition, there are no component void traps in the suction pipe that would result in a significant void being transported in whole to the pump suction.

Review of the Unit 1 Design Control Program determined that the design change review checklist has an explicit item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria. This change was made and added as an additional procedural barrier to prevent unintended consequences from plant changes and is an enhancement to the Design Control Program. The corresponding Unit 2 Design Control Program being used to complete construction of Unit 2 is a temporary procedure that will be supplanted by the current Unit 1 program.

1. **Gas volume acceptance criteria for each piping segment in each system where gas can accumulate.**

   a) **Pump Suction Piping**

The interim allowable gas accumulation in the pump suction piping is based on limiting the gas entrainment to the pump after a pump start. A Pressurized Water Reactor Owners Group (PWROG) Program established interim pump gas ingestion limits to be employed by the member utilities. The interim criteria addresses pump mechanical integrity only and are as follows:

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**WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems**

Table 1

| | **Interim Pump Gas Ingestion Tolerance Criteria** | | |
|---|---|---|---|
| | ***Single-Stage Pump*** | ***Multi-Stage Pump*** | ***Multi-Stage Pump*** |
| | | Stiff Shaft | Flexible Shaft |
| **Steady-State (> 20 seconds) Void Fraction** | 2 % | 2 % | 2 % |
| **Transient* Void Fraction** | 5 % for 20 seconds | 20 % for 20 seconds | 10 % for 5 seconds |
| **$Q_{B.E.P.}$ Range** **(Best Efficiency Point)** | 70 %-120 % | 70 %-140 % | 70 %- 120 % |
| **Pump Type (transient data)** | WDF - *Ingersoll-Rand 8x20 WDF* | CA - *Ingersoll-Rand 4x11 CA x8* | RLIJ - *Pacific 2.5"*, JHF - *Pacific 3.0"* |
| * The transient criteria are based on pump test data and vendor supplied information. | | | |

**b) Pump discharge piping which is susceptible to pressure pulsation after a pump start**

Pump discharge void volume acceptance criteria was based on maintaining pressure pulsations less than that which would cause a discharge pipe relief valve to lift or result in a hydraulic force that causes pipe stress to exceed allowable values. In order to meet these criteria, there must be no sudden changes in flow as the ECCS and RHR System Pumps start and compresses voids in the discharge pipe. These criteria are met when the discharge pipe has been filled to the isolation valve as this prevents an abrupt stopping of flow. In an otherwise full pipe system, voids resulting from unfavorable pipe slope or pipe bow or air trapped due to flow obstructions (e.g., orifice plates) are gradually compressed and do not result in an unacceptable pressure transient during pump start.

**c) Pump discharge piping which is not susceptible to water hammer or pressure pulsation following a pump start**

1. The PWROG methodology for Containment Spray evaluates the piping response as the Containment Spray Header is filled and compares the potential force imbalances with the weight of the piping. The net force resulting from the pressurization of the Containment Spray Header during the filling transient is a small fraction of the dead weight of the filled piping, and therefore the filling transient is well within the margin of the pipe hangers. The design basis of WBN includes a detailed calculation of the force imbalances during the filling of the Containment Spray discharge headers that shows the resultant force imbalances to be within the margin of the pipe hangers.

2. A PWROG methodology has been developed to assess when a significant gas-water water hammer could occur during switchover to hot leg injection. The methodology concludes: If the upstream valve has an opening time of approximately 10 seconds or greater and the downstream path to the Reactor Coolant System (RCS) is only restricted by check valve(s); no significant water hammer would occur, i.e.; none of the relief valves in the subject systems would lift, or none of the piping restraints would be damaged.

   The WBN ECCS flow path for hot leg injection from the RHR System Pumps has an upstream valve that has an opening time greater than 10 seconds and the downstream path to the RCS is only restricted by check valves. Therefore, consistent with the PWROG Program methodology, no significant water hammer will occur, i.e.; none of the relief valves in the subject systems would lift, or none of the piping restraints would be damaged.

   The ECCS Safety Injection Pumps (SIPs) are aligned for hot leg injection by stopping the SIPs, closing the Cold Leg Injection (CLI) valves and opening the hot leg injection valves prior to restarting the SIPs. For Unit 2 the ECCS throttle valves provide proper flow balancing to each ECCS injection leg to the reactor vessel. While this configuration was not explicitly evaluated in the PWROG methodology, the fact that the primary system is depressurized and flow to the hot legs does not stop after SIPs are restarted ensures no significant water hammer will occur, i.e.; none of the relief valves in the subject systems would lift, and none of the piping restraints would be damaged.

**d) Primary System Allowable Gas Ingestion**

The PWROG qualitatively evaluated the impact of non-condensable gases entering the RCS on the ability on the post-accident core cooling functions of the RCS. This evaluation assumed that 5 cubic feet of non-condensable gas at 400 psig was present in the CCP injection and SIS discharge piping concurrent with 5 cubic feet of non-condensable gas at 100 psig in the RHR discharge piping. The qualitative evaluation concluded that these quantities of gas will not prevent the ECCS from performing its core cooling function.

In summary, the effect on the ECCS core cooling function of non-condensable gas entering the primary system was assessed and found not to be limiting with respect to allowable void size.

2. **Discuss the results of the system P&ID and isometric drawing reviews to identify all system vents and high points.**

   The ECCS, RHR System and Containment Spray System mechanical flow diagrams, physical pipe drawings and isometric drawings have been reviewed. Results showed acceptable routing and arrangement similar to Unit 1.

3. **Identify new vent valve locations, modifications to existing vent valves, or utilization of existing vent valves based on the drawing review, and summarize the Corrective Actions, and schedule for completion of the Corrective Actions.**

   The Unit 2 review verified the need for additional vent valves for some locations to enhance venting capabilities. See Enclosure 1 Table 2 item 3.

4. **Discuss the results (including the scope and acceptance criteria used) of the system confirmation walk downs that have been completed for the portions of the systems that require venting to ensure that they are sufficiently full of water.**

   Suction/Discharge Pipe:

   The survey of the ECCS, RHR System and Containment Spray System will be performed after installation of pipe supports. See Enclosure 1 Table 2 item 4.

5. **Identify new vent valve locations, modifications to existing vent valves, or utilization of existing vent valves that resulted from the confirmatory walk downs, and summarize the Corrective Actions, and the schedule for completion of the Corrective Actions.**

   The survey of ECCS, RHR System and Containment Spray System pipe is not complete. Unit 2 will implement the enhanced venting capabilities performed for Unit 1 that are applicable to Unit 2. No new vent valve locations were identified for Unit 2 piping from the review of Unit 2 design drawings. Refer to EDCRs 53311, 52945, 53590 and 52637 vent valve locations based upon Unit 1 DCNs 20638, 23040, 30293, 36588, 39382, 51522, 51486, 51525, and 52257.

6. **Discuss the results of the fill and vent activities and procedure reviews for each system. (Note that routine periodic surveillance testing is addressed in the "Testing Evaluation" section of this template).**

   The review of ECCS, RHR System and Containment Spray System operating procedures for Unit 2 is not complete. Unit 2 will have procedures equivalent to Unit 1. See Enclosure 1 Table 2 item 5.

The Unit 2 review determined that UT inspection or dynamic venting of locations that could contain a significant void should this pipe be drained was not needed with the exception of the CS pump 2A-A suction line. This determination is based on the evaluations performed for GL 2008-01, which found that due to their configuration, the ECCS, RHR and CSS suction piping is self venting so dynamic venting, additional vent valves or UT examination is not necessary to ensure the suction piping of these systems is adequately filled. The suction line for CS Pump 2A-A will be evaluated to determine if a vent valve will be added or UT inspection will be performed. In addition, a detailed review of the ECCS and RHR discharge piping was performed in Unit 1 in the 2003 time period to identify and evaluate locations that could contain a significant void. As a result of this effort, vent valves were added to 12 locations in the discharge pipe of the ECCS and RHR.

The ECCS and RHR operating procedures were revised to vent at these additional locations. This change will be replicated in Unit 2. Based on final survey results (Enclosure 1 Table 2 item 4) additional valves will be added if required.

7. **Identify procedure revisions, or new procedures resulting from the fill and vent activities and procedure reviews that need to be developed, and summarize the Corrective Actions, and schedule for completion of the Corrective Actions.**

   As discussed in Item (6), above, the review is not complete. Unit 2 procedures will be equivalent to the Unit 1 procedures. (Enclosure 1 Table 2 item 5)

8. **Discuss potential gas intrusion mechanisms into each system for each piping segment that is vulnerable to gas intrusion.**

   All ECCS, RHR System and Containment Spray System suction pipe is water filled at greater than atmospheric pressure during power operation. This positive pressure precludes gas intrusion.

   There are no significant sources of gas in ECCS, RHR System and Containment Spray System suction pipe with two exceptions. 1)The water that circulates through the Centrifugal Charging Pumps (CCPs) is reactor coolant that contains hydrogen and noble gases that can come out of solution and form voids in the suction pipe. WBN Unit 1 vents periodically to remove voids from locations that due to pipe configuration could collect gas. 2) Voids can form in the Cold Leg Injection (CLI) lines due to primary system and Cold Leg Accumulator (CLA) leakage. Primary system and CLA leakage is monitored and trended. In addition, WBN Unit 1 operating experience is that this leakage results in pressurization of the ECCS discharge pipe. These indicators would be used to assess the need for an increase in the frequency of ECCS discharge pipe venting (through the Corrective Action Program).

The Safety Injection Pumps (SIPs) and Residual Heat Removal Pumps (RHRPs) are the intermediate head and low head ECCS Pumps, respectively. These pumps are aligned to their CLI lines during power operation. These pumps are individually tested each quarter in a configuration that results in the compression of any voids in their CLI lines. Recent Watts Bar Unit 1 operating experience from these quarterly tests has shown that unacceptable pressure pulsations or hydraulic forces do not occur when these pumps are started. This is the basis for the conclusion that a successful quarterly test of the SIPs and RHRPs (i.e.; no water hammer) provides verification that voids in the SIP and RHRP discharge pipe are below that which significantly affect their safety functions. Preoperational tests for Unit 2 will provide direct verification for Unit 2 capabilities prior to Unit 2 fuel load.  See Enclosure 1 Table 2 item 6.

**9. Ongoing Industry Programs**

Ongoing industry programs are planned in the following areas which may impact the conclusions reached during the Design Evaluation relative to gas accumulation. The activities will be monitored to determine if additional changes to the plant design may be required or desired to provide additional margin.

- Gas Transport in Pump Suction Piping

The PWROG has initiated testing to provide additional knowledge relative to gas transport in large diameter piping. One program performed testing of gas transport in 6-inch and 8-inch piping. Another program will perform additional testing of gas transport in 4-inch and 12-inch low temperature systems and 4-inch high temperature systems. This program will also integrate the results of the 4-inch, 6-inch, 8-inch'and 12-inch testing.

- Pump Acceptance Criteria

Long-term industry tasks were identified that will provide additional tools to address GL-2008-01 with respect to pump gas void ingestion tolerance limits.

**10. Provide a detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.**

This information is in Enclosure 1 Section B, Table 2.

**Enclosure 1**

**WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems**

## Procedures Evaluation

1. **Identify procedure revisions, or new procedures resulting from the periodic venting or gas accumulation surveillance procedure review that need to be developed, and summarize the Corrective Actions, and schedule for completion of the Corrective Actions. For example, new or revised procedure(s) were implemented for additional leak testing or periodic maintenance to demonstrate the leak tightness of valves in potential gas intrusion paths.**

   The procedures that are used to meet Surveillance Requirements (SR) 3.5.2.3 will be issued to require that, in the event of an extended gas release, a report is entered into the Corrective Action Program. These procedures will be based upon Unit 1 surveillance procedures. See Enclosure 1 Table 2 item 7.

2. **Discuss how procedures adequately address the manual operation of the RHR System in its decay heat removal mode of operation. Include how the procedures assure that the RHR System is sufficiently full of water to perform its decay heat removal safety function (high point venting or UT) and how pump operation is monitored by plant personnel (including a description of the available instrumentation and alarms).**

   Procedures will require venting of the suction and discharge pipe in the RHR System, just prior to it being placed in service for shutdown cooling (Enclosure 1 Table 2, item 5). When placed in service for shutdown cooling, the isolation valves in the suction pipe are opened and the RHR System pressurizes to primary system pressure prior to starting the RHR System Pumps. The RHR System would have to have a high void concentration in the standby mode to contain a significant void once pressurized for shutdown operation. The lack of large voids during standby mode will be confirmed for Unit 2 in preoperational testing (Enclosure 1 Table 2, item 6).

   Operators have pressure and flow instrumentation to monitor the RHR System and procedures to mitigate a loss of the RHR System. The Unit 2 instrumentation is identical to Unit 1.

3. **Summarize the results of the procedure reviews performed to determine that gas intrusion does not occur as a result of inadvertent draining due to valve manipulations specified in the procedures, system realignments, or incorrect maintenance procedures.**

   WBN Unit 1 operating experience shows that testing, maintenance or system alignment changes do not result in inadvertent draining or the introduction of voids into the ECCS, RHR System or Containment Spray System. This verification will be confirmed by preoperational testing on Unit 2. Unit 2 will implement equivalent procedures to Unit 1 (Enclosure 1 Table 2, items 5 and 6).

**WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems**

## Testing Evaluation

4. **Discuss the results of the preoperational testing for venting or gas accumulation and performance testing review.**

WBN Unit 2 has not performed Preoperational tests that include venting and performance testing of the ECCS.

ECCS Injection from the Refueling Water Storage Tank (RWST)

The relief valves on the cold leg injection lines from the RHR pumps have a setpoint > 350 psi above the maximum discharge pressure of the pumps when their suctions are aligned to the RWST for their ECCS function. The relief valves on the cold leg injection lines from the SIPs have a set point > 200 psi above the maximum discharge pressure of the SIPs when their suctions are aligned to the RWST for their ECCS function. Large voids in the discharge piping can result in the system relief valves opening due to inertial effects (water hammer) as the voids are collapsed at locations of significant flow perturbation such as a closed system valve. Water hammer will not occur when flow acceleration due to collapsing voids is small or does not occur as the pressure increases in the cold leg injection lines to the maximum discharge pressure of the pumps. The absence of substantial voiding in a section of horizontal pipe, thus limiting inertial impacts at the closed injection isolation valve or closed primary check valve, will result in acceptable pressurization rates and magnitudes.

The above conclusion is consistent with operating experience on Unit 1. Prior to June, 2008, there were horizontal sections of SIPs' discharge pipe near closed injection valves that could not be vented. This configuration resulted in the lifting of the SIP discharge relief valves during periodic testing of the SIPs. After the addition of vents, which allowed this horizontal pipe to be filled, subsequent periodic tests of the SIPs have not resulted in the lifting of their discharge relief valves. These additional vents will be replicated in Unit 2 by EDCR 53311 (Enclosure 1 Table 2, item 3). Unit 2 preoperational tests will also verify this conclusion.

There have been no instances of a lifting of a relief valve on the discharge of the RHRS pumps during their periodic tests in Unit 1. This will be verified in Unit 2 preoperational tests (Table 3, item 6). The maximum discharge pressure of these pumps when aligned to the RWST is sufficiently below their discharge relief valves' set point that the valves should not open. Therefore, with respect to the Unit 2 licensing basis, the failure of one of the ECCS or RHRS relief valves to close would be considered a single failure (as opposed to a consequential failure). The flow from either train of RHR exceeds the minimum flow required by the safety analysis even with a loss of injection flow to the RCS due to a stuck open relief valve. The discharge from these relief valves is routed inside containment to the pressurizer relief tank. Therefore, there will be no loss of ECCS water or RCS inventory from the containment sump as a result of a pressure pulse causing a relief valve to open and then failing to close.

ECCS Injection from the Containment Sump

When the SIPs are aligned to the discharges of the RHR pumps for containment sump recirculation, the maximum discharge pressure of the pumps is close to the relief valve set points (< 50 psi difference). However, in this case, operating procedures prevent the SIPs from being restarted unless the RCS pressure is well below the discharge pressure of the SIPs. This means that flow in the discharge pipe cannot abruptly stop because the discharge pressure of the SIPs will be above RCS pressure when the SIPs are restarted. As a result, pressure pulsations that could cause a relief valve to open would not occur.

RHR Shutdown Cooling

When the RHR pumps are aligned for shutdown cooling, the maximum discharge pressure of the pumps would be close to the relief valve set points (< 25 psi difference). However, in this case, flow in the discharge pipe cannot abruptly stop because the discharge pressure of the RHR pumps is above RCS pressure. As a result, pressure pulsations that could cause a relief valve to open would not occur.

5. **Describe how gas voids are documented (including the detection method such as venting and measuring or UT and void sizing and post venting checks), dispositioned (including method(s) used such as static or dynamic venting), and trended, if found in any of the subject systems.**

   As discussed in Item (2), above, procedures that are used for meeting Technical Specification SR 3.5.2.3 will be revised to require that a report is entered into the Corrective Action Program for an extended gas release in the ECCS and RHR System. (Enclosure 1 Table 2, item 7)

6. **Provide a detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.**

   This information is in Enclosure 1 Section B Table 2.

<u>**Corrective Actions Evaluation**</u>

1. **Summarize the results of the reviews regarding how gas accumulation has been addressed at your site.**

   WBN's Corrective Action Program which is applicable to Unit 1 and Unit 2 is used to document gas intrusion / accumulation issues as potential nonconforming conditions. As part of these Corrective Action Programs, Problem Evaluation Reports related to plant equipment are evaluated for potential impact to operability and reportability. Therefore, WBN's review concluded that issues involving gas intrusion / accumulation will be properly prioritized and evaluated under the Corrective Action Program.

2. **Provide a detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.**

   This information is in Enclosure 1 Section B Table 2.

   <u>**Conclusion**</u>

   Based upon the above, TVA has developed a plan that WBN Unit 2 will be in conformance with 10 CFR 50, Appendix B, Criterion III, V, XI, XVI, and XVII, and is tracked for final resolution, as described in Section B.

## B. DESCRIPTION OF CORRECTIVE ACTIONS, SCHEDULE AND JUSTIFICATION FOR SCHEDULE

Enclosure 1 Table 2 provides a list of commitments for WBN Unit 2:

1. **Provide a detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.**

   TS improvements such as Integrated Standard Technical Specification (ISTS) SR 3.5.2.3 are being addressed by the Technical Specifications Task Force (TSTF) to provide an approved TSTF Traveler for making changes to individual licensee's TS related to the potential for unacceptable gas accumulation. The development of the TSTF Traveler relies on the results of the evaluations of a large number of licensees to address the various plant designs. TVA is continuing to support the industry and Nuclear Energy Institute (NEI) Gas Accumulation Management Team activities regarding the resolution of Generic TS changes via the TSTF Traveler process. After NRC approval of the Traveler, TVA will evaluate its applicability to the WBN, and evaluate adopting the Traveler to either supplement or replace the current TS requirements. See Enclosure 1 Table 2 item 1.

**Enclosure 1**

**WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems**

TABLE 2

| Item Description | Date |
|---|---|
| 1. TVA will evaluate adopting the revised Integrated Standard Technical Specification (ISTS) SR 3.5.2.3 (NUREG 1431) at WBN. | Within 6 months of NRC approval of the Traveler |
| 2. Complete evaluation of CS pump 2A-A pipe chase horizontal suction piping for venting. Add a vent valve to this location or conduct periodic UT examinations if necessary prior to fuel load. | 90 days prior to fuel load |
| 3. Add vent valves to selected locations in the ECCS and RHRS piping to enhance filling and venting. | 90 days prior to fuel load |
| 4. Complete walk down survey of ECCS and RHRS piping and evaluate the piping for latent voids that could exceed 5% of the pipe cross sectional area. | 90 days prior to fuel load |
| 5. Operating procedures are being revised to improve instructions for filling and venting portions of the ECCS discharge pipe. | 90 days prior to fuel load |
| 6. Complete Preoperational tests on ECCS and DHRS systems to confirm Unit 1 operating experience showing no gas intrusion/accumulation issues. | 90 days prior to fuel load |
| 7. Periodic venting procedures used to meet SR 3.5.2.3 are being developed to require that, for an extended gas release, a report is entered into the Corrective Action Program. | 90 days Prior to fuel load |

A Commitment for each open item in the above Table is listed in Enclosure 3.

In addition, the BWR/PWROG is proceeding with various programs on the affect of voids on safety system performance. TVA will follow the BWR/PWROG Programs and take additional actions, if needed to ensure system operability, as the results of these programs becomes available.

Revision to ISTS SR 3.5.2.3 (NUREG 1431) may result in a requirement that quantitative void limits for some locations in the ECCS and RHR System are established and that void monitoring be implemented. A TS SR change of this scope would require additional plant specific calculations and plant modifications may be required to implement void monitoring. The timeframe for evaluating the revised TS for adoption is left somewhat open at this time due to the recently developing NRC and industry efforts.

# WBN Unit 2 Response After Completion of the Engineering for the ECCS, RHR, and CSS systems in Unit 2 to NRC (GL) 2008-01: Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems

## Conclusion

WBN Unit 2 will complete the required evaluations and modifications and provide a submittal consistent with the information requested in the GL 90 days prior to fuel load. The submittal will provide: a statement regarding which actions are completed, the schedule for completing the remaining actions, and the basis for that schedule.

**Enclosure 2**

**Response to Request for Additional Information Regarding NRC Generic Letter 2008-01**

## *NRC Question 1*

*Please clarify the specific systems reviewed* as *part* of *the GL 2008-01 review.*

## TVA Response

TVA's Generic Letter (GL) 2008-01 Review evaluated the following systems:

1. Chemical Volume and Control System (CVCS): The CVCS performs inventory and chemical addition during normal operation and includes the centrifugal charging (CC) pumps that serve as the high-head pumps in the Emergency Core Cooling (ECC) System (ECCS).

2. Safety Injection (SI) System: The SI System (SIS) includes the safety injection pumps (SIPs) that serve as the intermediate head pumps in the ECCS.

3. Residual Heat Removal (RHR) System: The RHR System (RHRS) performs normal shutdown cooling and includes the residual heat removal pumps that serve as the low head pumps in the ECCS. The RHR pumps can also be aligned to containment spray headers to augment containment heat removal.

   (Note: GL 2008-01 refers to the Decay Heat Removal (DHR) System and, in its October 2008 response, TVA used the GL 2008-01 DHR terminology when describing the Watts Bar Nuclear Plant (WBN) RHRS. In this present response, TVA refers to the system by the RHRS nomenclature used in the WBN Final Safety Analysis Report).

4. Containment Spray (CS) System: The CS System (CSS) is the system that, in conjunction with the ECCS, performs containment heat removal.

## *NRC Question 2*

*Void acceptance criteria has been updated since TVA's submittal* of *its 9-month response. How has WBN Unit* 1 *addressed the updated information? Note: mechanical integrity only is not considered adequate to ensure pump operability.*

## TVA Response

The Pressurized Water Reactor Owner's Group (PWROG) developed pump suction void acceptance criteria to support the industry's evaluations for the GL 2008-01 required 9-month responses. These pump suction void acceptance criteria ensure the CC, SI, RHR, and CS pumps will not be mechanically damaged by air ingestion. It was recognized at the time these criteria were developed that pump head also decreases when the CC, SI, RHR, and CS pumps ingest air. In order to maintain the CCS, SIS, RHRS, and CSS flow rates as modeled in the safety analyses, the total degradation in pump head from all phenomena (including normal wear) needs to be less than the head degradation allowed by the safety analyses. Limiting head degradation results in more restrictive suction void acceptance criteria than the mechanical damage suction void acceptance criteria.

Limiting head degradation is the updated criteria referred to in this question (see row 5 of Table 2 in Revision 2 to *NRC Staff Criteria for* Gas *Movement in the Suction Lines and Pump Response to* Gas, dated March 26, 2009).

When considering the effect of head degradation due to air ingestion, the CC, SI, RHR, and CS pumps remain capable of providing the flows used in the safety analyses due to the design of these systems:

- There are no continuous sources of gas in the CC, SI, RHR or CS pump suction pipe; no air entraining vortexes form in the Refueling Water Storage Tank (RWST) and containment sump during ECC and CS injection or recirculation.

- The CC, SI, RHR, and CS pumps are located below their suction sources and the suction pipe self vents to the RWST. In Unit 2 the ECCS suction piping contains one inverted pipe "U". The last horizontal run in the CS Pump 2A-A suction piping to the pump is actually an intermediate high point between the pump and the RWST due to the configuration of the piping in the Auxiliary Building pipe chase. A similar condition does not exist for the CS Pump 2B-B. The final walkdown for Unit 2 has not been completed but the configurations between the plants are essentially the same. An evaluation of CS pump 2A-A pipe chase horizontal suction piping for venting will be performed. A vent valve will be added to this location or periodic UT examinations will be performed if necessary prior to fuel load.( Enclosure 1 Table 2, item 2)

- An analysis performed by Westinghouse (CN-SEE-IV-09-22, Revision 0) in support of GL 2008-01 determined that the suction header could contain an allowable void fraction of 5% without adversely affecting the CS pumps. The CS pumps will be periodically tested at a flow rate of approximately 4,000 gpm in the quarterly pump surveillance tests. This flow rate would disperse and transport any potential voids in their suction pipe and part of their discharge piping to the RWST. Therefore, voids that could damage the CS pumps are not expected to occur in this piping.

Pump head degradation may be from latent voids in the slopes and bows of nominally horizontal pipe. The suction pipe in the CCS, SIS, RHRS, and CSS contains horizontal headers upstream of the last vertical pipe to the inlet of the pumps. Any latent voids in the suction pipe accumulate at the down elbow in this pipe where the turbulence induced by the elbow breaks up the voids into small bubbles before being drawn down the vertical pipe to the inlet of the pump. As a result, the void fraction in the flow stream that enters the pump will be ~1% by volume and not result in a significant pump head loss. In addition, the pump head loss that does occur will be of short duration due to the small potential void volumes in the slopes and bows of the CC, SI, RHR, and CS pump suctions.

Therefore, there was no need to re-evaluate the CCS, SIS, RHRS, or CSS as a result of the new void acceptance criteria.

### *NRC Question 3*

*In light* of *updated acceptance criteria, are any piping segments susceptible* to *unacceptable void limits since the piping systems were previously evaluated against other criteria?*

### TVA Response

As discussed in the response to Question 2 of this Request for Additional Information, including the discussion of the CS 2A-A pump suction when lined up to the RWST, the evaluations of the suction of the WBN Unit 2 pumps determined that the design, construction, and proposed operation of the CC, SI, RHR, and CS pump suction piping prevents:

- A continuous source of voids of any size being transported to the CC, SI, RHR, or CS pump suctions; and,
- A latent void in the CC, SI, RHR, or CS pump suction piping that could result in a limiting void being transported to these pumps.

An evaluation of CS pump 2A-A pipe chase horizontal suction piping for venting will be performed. A vent valve may be added to this location or periodic UT examinations may be conducted if necessary prior to fuel load.

### *NRC Question 4*

*In TVA's discussion* of *pressure pulsations, TVA states, "These criteria are usually met when the discharge pipe has been filled to the isolation valve* as *this prevents an abrupt stopping* of *flow." What is meant by "usually"? What are the criteria and are there instances when the criteria are not met?*

### TVA Response

This question relates to pump discharge void volume acceptance criteria and the impact of pressure pulsations as discussed on page E3-4 of WBN Unit 1 October 11, 2008 response. The intent of the discussion in the October 11, 2008 response was to express that by ensuring that the discharge piping was filled to the isolation valve, there would be no pressure pulsations from gas voids that could affect system operation. The fill criteria include venting until a steady stream of water is coming out of the vent. This will ensure the system is full.

The October 11, 2008 discussion also intended to allow for circumstances where gas is found when venting the discharge pipe indicates the pipe is not completely filled. When gas is found, it does not meet the acceptance criteria, but additional quantitative analysis is undertaken to determine whether the amount of gas could create concerns related to excessive pressure pulsation.

The drawing review and survey data taken for the WBN Unit 1 GL 2008-01 evaluation verified that after being filled and vented, the discharge pipe is full except for latent voids that could exist due to adverse slope or bow in nominally horizontal pipe. For Unit 1 the detailed slope and bow measurements taken for the nominally horizontal pipe were evaluated to determine if any potential latent voids could exceed 5% of the pipe cross sectional area. Pipe segments that could contain latent voids exceeding the 5% screening criteria received further evaluation, where the total gas volume in the pipe segment was compared to a 0.5 cubic feet acceptance criteria for pipes larger than 3 inches in diameter. WBN Unit 2 will complete a walk down survey of ECCS and RHRS piping and evaluate the piping for latent voids that could exceed 5% of the pipe cross sectional area. (Enclosure 1 Table 2 item 4)

### *NRC Question 5*

*How were the system primary gas limits determined? Did the evaluation include the possibility that all gas is sent to the pump in one slug?*

## TVA Response

The PWROG qualitatively evaluated the impact of gases entering the Reactor Coolant System (RCS) on the ability of the post-accident core cooling functions of the ECCS. This evaluation assumed that:

- 5 cubic feet of gas at 400 psig would be injected to the RCS from the CC pumps and SI pumps; and,
- 5 cubic feet of gas at 100 psig would be injected to the RCS from the RHR pumps.

The evaluation concluded that these quantities of gas do not prevent the ECCS from performing its core cooling function. The quantity of gas determined to be acceptable based on the above described limits is very large compared to the total volume of the ECCS. Thus the effect on the ECCS core cooling function of gas entering the primary system was found not to be limiting with respect to allowable void volume.

A void of the size allowed by the primary system gas limits was not evaluated as potentially reaching the pump suction as a slug of air because the primary system gas limits were not used as an allowable void size in evaluating the acceptability of voids in the ECCS suction pipe. A void size based on primary system gas limits is 'much too large to be acceptable in the suction pipe. Instead, as discussed in the response to Question 2, the acceptability of potential voids in the suction pipe is based on:

- Suction pipe voids existing only in the slopes and bows of nominally horizontal pipe and the inverted “U” in the CS pump 2A-A suction piping. An evaluation of CS pump 2A-A pipe chase horizontal suction piping for venting will be completed. A vent valve may be added to this location or periodic UT examinations may be conducted if necessary prior to fuel load. (Enclosure 1 Table 2 item 2) and,
- The location of the horizontal header upstream of the last vertical pipe to the suctions of the CC, SI, RHR, and CS pumps.

***NRC Question 6***

*In Testing Evaluation Section 2, TVA stated that procedures are being updated to include entry into the corrective actions program (CAP) if extended gas releases are found. What defines an extended gas release and why aren't all found voids entered into the CAP?*

## TVA Response

The venting procedures that will be used by WBN Unit 2 to meet the requirements of SR 3.5.2.3 and 3.5.3.1 will require that any gas release during venting be timed and entered into the CAP for evaluation. The ECCS and RHR discharge pipe is expected to be full of water at all times so any bubbles discharged subsequent to the purging of the vent pipe would indicate a condition requiring further evaluation via the CAP regardless of the duration of the gas release. Periodic venting procedures used to meet SR 3.5.2.3 are being developed to require that, for an extended gas release, a report is entered into the Corrective Action Program. (Enclosure 1 Table 2 item 7)

**Enclosure 3**

**LIST OF WBN-SPECIFIC COMMITMENTS**

1. TVA will evaluate adopting the revised ISTS SR 3.5.2.3 (NUREG 1431) at WBN within 6 months of NRC approval of the Traveler.
2. Complete evaluation of CS pump 2A-A pipe chase horizontal suction piping for venting. Add a vent valve to this location or conduct periodic UT examinations if necessary. (90 days prior to fuel load.)
3. Add vent valves to selected locations in the ECCS and RHRS piping to enhance filling and venting. (90 days prior to fuel load.)
4. Complete walk down survey of ECCS and RHRS piping and evaluate the piping for latent voids that could exceed 5% of the pipe cross sectional area. (90 days prior to fuel load.)
5. Operating procedures are being revised to improve instructions for filling and venting portions of the ECCS discharge pipe. (90 days prior to fuel load.)
6. Complete Preoperational tests on ECCS and RHRS systems to confirm Unit 1 operating experience showing no gas intrusion/accumulation issues. (90 days prior to fuel load.)
7. Periodic venting procedures used to meet SR 3.5.2.3 are being revised to require that, for an extended gas release, a report is entered into the Corrective Action Program. (90 days prior to fuel load.)