TENNESSEE VALLEY AUTHORITY

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SEP 30 1988

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

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
	)	50-296
	)	50-390
	)	50-391
	)	50-438
	)	50-439

BROWNS FERRY (BFN), WATTS BAR (WBN), AND BELLEFONTE (BLN) NUCLEAR PLANTS - NRC BULLETIN (NRCB) 88-04, "POTENTIAL SAFETY-RELATED PUMP LOSS"

This letter provides TVA's response to NRC questions regarding the adequacy of miniflow systems for safety-related pumps. These questions were expressed in NRCB 88-04, which was issued by the NRC on May 5, 1988.

Enclosure 1 provides the results of TVA's evaluation of the issues identified in NRCB 88-04 for BFN. A submittal date of September 30, 1988, was discussed with David Moran of NRC's Office of Special Projects (NRC-OSP) on July 1, 1988.

This letter also confirms the schedule for submittal of responses for WBN and BLN as discussed with Raj Auluck of NRC-OSP on July 1, 1988. Because of the current status of WBN, TVA will provide a response to NRCB 88-04 for WBN by February 27, 1989. Because of the recent deferral of BLN, TVA will provide a schedule for responding to NRCB 88-04 for BLN after resumption of design and construction activities.

TVA's response for Sequoyah Nuclear Plant units 1 and 2 was provided on August 2, 1988, to support the unit 1 restart schedule.

The commitments made in this submittal are stated in enclosure 2.

If you have any questions, please telephone D. L. Williams at (615) 632-7170.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

R. Gridley, Manager
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Enclosures
cc: See page 2

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U.S. Nuclear Regulatory Commission

SEP 30 1988

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ENCLOSURE 1

BROWNS FERRY NUCLEAR PLANT (BFN) UNITS 1-3
NRC BULLETIN (NRCB) 88-04
POTENTIAL SAFETY-RELATED PUMP LOSS

The purpose of NRCB 88-04 was to request licensees to investigate and correct, as applicable, two miniflow design concerns for safety-related system pumps. The first concern involves the potential for dead-heading of one or more pumps that have a miniflow line common to two or more pumps or other piping configurations that do not preclude pump-to-pump interaction during miniflow operation. The second concern is whether or not the installed miniflow capacity is adequate for even a single pump in operation.

BACKGROUND:

The original design basis for sizing the minimum flow lines for safety-related BWR systems is to provide sufficient flow to avoid overheating the pumps due to low flow. However, current pump vendor guidelines for minimum flow are based on avoiding hydraulic instability in addition to avoiding pump overheating, leading to higher suggested minimum flow values than those used in BWR design. Hydraulic instabilities can occur at low flow rates due to flow separation across the impeller vane, which can lead to asymmetrical shaft and bearing loads in addition to pump and piping vibration. Since the pump vendor guidelines are only applicable for continuous or intermittent low flow operation, there are no guidelines for low flow limits for infrequent operation such as that experienced for only a limited postulated range of BWR loss-of-coolant accident (LOCA) events.

In addition, the pump minimum flow rate can be reduced (possibly leading to a condition where the pump is being run dead-headed) if there is a single minimum flow line for a pair of pumps operating in parallel. If the pumps have different pump shutoff heads, the pump with the higher shutoff head will deliver a greater flow rate; if there is a significant difference between the shutoff heads, the pump with the lower shutoff head may become dead-headed.

When the minimum flow discharge lines from two or more pumps join at some point to form a common line, there is a potential for interaction between the pumps. If the piping configuration is not controlled, the pump with the higher discharge pressure could reduce the flow through the pump with lesser discharge pressure to the point where it is inadequate for long term integrity.

If the pumps' minimum flow discharge lines are orificed (backloaded) in the individual pump discharge lines prior to the junction between the two pipes, and if the common line is large enough in flow area such that its resistance is a relatively small part of the overall hydraulic resistance, there should be little adverse pump-to-pump interaction. The pumps can be expected to operate individually or in unison with no problems.

However, if the minimum flow discharge lines are not individually orificed, but the common line is orificed or provides greater flow resistance than the individual lines, interaction between the two pumps may occur. The severity of the attenuation of minimum flow through any pump depends on the shape of the head-flow curves of the pumps, and the magnitude of the mismatch between the pumps.

If the characteristic curve is such that a small change in flow results in a relatively large change in developed head, it is probable that little operational difficulty would result from an undesirable piping configuration.

However, if a relatively large change in flow resulted in only a small change in developed head, some problems could occur. Further, the rate of attenuation of minimum flow through the lesser pump would be expected to accelerate with time.

DISCUSSION

The similarity of the boiling water reactor (BWR) designs prompted the BWR Owner's Group (BWROG) to prepare a generic response to NRCB 88-04. TVA endorses the BWROG position as stated in their letter (BWROG-8836) from D. N. Grace to the NRC dated June 29, 1988. The BWROG response is supplemented herein by plant-specific information for BFN.

TVA evaluated the following BFN safety-related system pumps for these concerns as required by items 1, 2 and 3 of Actions Requested of NRCB 88-04:

- Residual Heat Removal (RHR) including Low-Pressure Coolant Injection (LPCI), Containment Spray Cooling (CSC), Suppression Pool Cooling (SPC), and Shutdown Cooling (SCS)
- Emergency Equipment Cooling Water (EECW)
- Reactor Core Isolation Cooling (RCIC)
- High Pressure Coolant Injection (HPCI)
- Residual Heat Removal Service Water (RHRSW)
- Core Spray Cooling (CS)

The system-by-system evaluation included the review of design drawings, design data, surveillance test data, available maintenance history, and pump supplier information where available.

Item 4 of Actions Requested of NRCB 88-04 requests a written response that (a) summarizes the problems and the systems affected, (b) identifies the short-term and long-term modifications to plant operating procedures or hardware that have been or are being implemented to ensure safe plant operations, (c) identifies an appropriate schedule for long-term resolution of this and/or other significant problems that are identified as a result of this bulletin, and (d) provides justification for continued operation particularly with regard to General Design Criterion 35 of Appendix A to Title 10 of the Code of Federal Regulations (10 CFR 50), "Emergency Core Cooling," and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling System for Light Water Nuclear Power Reactors."

TVA's response to Item 4 follows.

RESPONSE:

4.(a) SUMMARY OF PROBLEMS AND SYSTEMS AFFECTED

Potential for Dead-Heading

The RHRSW/EECW pumps normally run far above minimum flow requirements when they are operated; therefore, pump-to-pump interaction that could cause dead-heading of a pump is not a concern.

The HPCI and RCIC systems have no parallel pumps; therefore, pump-to-pump interaction that could cause dead-heading is not a concern.

The RHR system has parallel pairs of RHR pumps in independent loops. The two pumps in each loop have separate miniflow lines which combine into a common line downstream of individual restricting orifices. A single flow control valve is provided for each pair of pumps. As stated in the summary above, this configuration is not expected to result in adverse pump to pump interactions. Miniflow bypass calculations confirm that the line losses in the common downstream line are a small part of the overall resistance in the miniflow bypass piping; therefore, adverse pump-to-pump interactions are not a concern.

The CS system consists of two independent spray loops with two parallel pumps in each loop. Each pump is provided with a miniflow bypass line containing a restricting orifice. The miniflow bypass lines from each of the two pumps in each loop combine into a common line downstream of the restricting orifices. This common line contains a normally open valve which automatically isolates the line upon indication of adequate pump flow that is initiated from pump discharge flow measurement for each CS loop. As with the RHR pumps, miniflow bypass calculations confirm line losses to be small in the downstream piping; therefore, adverse pump-to-pump interaction is not a concern.

Adequacy of Pump Minimum Flow

The RHRSW/EECW pumps are normally run above minimum flow requirements and are limited to flows above minimum flow during normal operation and operability testing. The TVA operating instructions for these pumps contain a precautions and limitations statement to prevent pump damage from low flow operation by minimizing operation in the minimum flow mode. TVA does not consider the bulletin concern to be a problem for these pumps.

The HPCI and RCIC pumps' miniflow bypass valves are automatically opened upon a low pump discharge flow signal. Flow limiting orifices in the miniflow bypass lines are sized by the pump vendor and verified by acceptable performance and testing results. The miniflow lines are used only briefly during startup of these systems for testing or transient/accident mitigation. Both systems utilize full flow test loops and operation during miniflow operability testing is limited to 5 minutes. Miniflow operation during startup for transient or accident mitigation is limited to the short time necessary to achieve full flow from the pumps. TVA does not consider the bulletin concern to be a problem for these pumps.

The RHR and CS pumps both utilize full flow test loops. Operating instructions and surveillance instructions caution that continuous miniflow operation should not normally exceed five minutes. For a small-break Loss of Coolant Accident (LOCA), the RHR (LPCI) or CS pumps are expected to operate in the miniflow mode for less than 30 minutes. These periods are within the pump vendors' criteria for intermittent operation in the miniflow mode. Therefore, the potential for excessive wear attributable to miniflow operation is negligible. TVA does not consider the bulletin concern to be a problem for these pumps.

Verification of the adequacy of the miniflow line sizing for the RHRSW/EECW, RHR and CS pumps is considered to be a portion of the essential calculations for BFN. As such, it is included under TVA's Design Calculation Review Program for essential calculations, commitment items 78, 78a, and 78b of the Browns Ferry Nuclear Performance Plan (BFNPP) Volume 3, Revision 1 (calculation nos. MD-Q2023-88125, MD-Q2074-87156, and MD-Q2075-87214).

4.(b) SHORT-TERM AND LONG-TERM MODIFICATIONS

Neither hardware nor procedural modifications have been identified as a result of TVA's review of NRCB 88-04. The aforementioned Design Calculation Review Program requires that any significant deficiencies concerning the adequacy of safety-related pump miniflow designs for BFN be documented, tracked on a condition adverse to quality report (CAQR), and resolved under TVA's quality assurance program. However, TVA does not expect hardware modifications to be required.

4.(c) SCHEDULE FOR LONG-TERM RESOLUTION

TVA's Design Calculation Review Program for essential calculations, commitment items 78, 78a, and 78b of the BFNPP Volume 3, Revision 1, is required to be completed prior to restart of BFN unit 2.

In accordance with item 5 of Actions Requested of NRCB 88-04, TVA will provide a supplemental response to NRCB 88-04 for BFN within 30 days of completion of the actions discussed in item 4.(b).

4.(d) JUSTIFICATION FOR CONTINUED OPERATION

The BFN safety-related pumps have been in service for about 13 years and have no history of excessive impeller wear. Abnormal degradation of performance that could be attributed to low flow effects from testing and normal system starts has not been detected from routine in service inspections performed in accordance with ASME Section XI.

Miniflow operation of the affected safety-related pumps is minimized during the short periods of pump startup occurring as a result of routine testing or a LOCA signal.

TVA's response to the concerns of NRCB 88-04, as provided by the BWROG's generic response and supplemented herein for BFN, provides the basis for concluding that restart and subsequent operation of BFN is justified with regard to the bulletin concerns.

ENCLOSURE 2

BFN, WBN, AND BLN
NRC BULLETIN (NRCB) 88-04
POTENTIAL SAFETY-RELATED PUMP LOSS

LIST OF COMMITMENTS

1. TVA will provide a response to NRCB 88-04 for WBN by February 27, 1989.

2. TVA will provide a schedule for responding to NRCB 88-04 for BLN after resumption of design and construction activities.

3. TVA will provide a supplemental response to NRCB 88-04 for BFN within 30 days of completion of the action discussed in item 4.(b).