TVA

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AUG 12 1994

CDR-50-390/94-08 10 CFR 50.55(e)

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

Gentlemen:

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

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - SUPPLEMENTAL REPORT FOR RESIDUAL HEAT REMOVAL PUMP 1B-B FAILURES - CDR-50-390/94-08

The purpose of this letter is to provide a supplemental report to address failure of the 1B-B residual heat removal pump at WBN during preoperational testing. The subject deficiency, documented in Incident Investigation II-W-94-014, Revision 1, was initially reported to the NRC Operations Center on June 17, 1994. In TVA's initial report dated July 14, 1994, TVA committed to providing a supplemental report by August 12, 1994, to address the root cause and any required corrective actions. Enclosure 1 to this letter contains TVA's supplemental report on this subject. Enclosure 2 provides a list of commitments made in this submittal.

If you have any questions, please telephone P. L. Pace at (615) 365-1824.

Sincerely,

Dwight E. Nunn
Vice President
New Plant Completion
Watts Bar Nuclear Plant

Enclosures
cc: See page 2

AUG 12 1994

cc (Enclosures):

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 1
RESIDUAL HEAT REMOVAL PUMPS
CDR 50-390/94-08
FINAL REPORT

DESCRIPTION OF DEFICIENCY

On April 9, 1994, Residual Heat Removal (RHR) Pump 1B-B was started in parallel with RHR Pump 1A-A. Seven minutes later, RHR Pump 1B-B was manually shutdown as a result of increasing motor current. Pump disassembly showed that the upper casing ring was fused to the impeller and had shrunk away from the stuffing box extension. The impeller and ring were sectioned, microphotographed and metallurgically analyzed. This analysis showed that the Monel casing ring was friction welded to the stainless steel impeller.

Following this failure, TVA performed corrective actions to address component alignment and operating processes. However, on June 6, 1994, RHR Pump 1B-B was once again manually shutdown as a result of high motor current. In the second event, Pump 1B-B was being brought on line without RHR Pump 1A-A operating. Pump disassembly showed that the upper casing ring was once again fused to the pump impeller.

The RHR pumps at WBN are Ingersoll Rand, Model 8X20 WDF, Centrifugal pumps.

SAFETY IMPLICATIONS

The RHR system at WBN is a safety-related system designed to ensure adequate heat removal during shutdown conditions (Modes 4, 5, and 6) and following a loss of coolant accident (LOCA) such that the acceptable fuel design limits are not exceeded. Following a LOCA, the RHR system provides low head flow, from the refueling water storage tank (RWST), to the reactor coolant system (RCS) during the injection phase. During the recirculation mode of cooling following a LOCA, the RHR system provides the capability to pump water from the containment sump to the RCS.

In each of the events discussed above (DESCRIPTION OF DEFICIENCY), the failure of the RHR pump occurred following the introduction of heated water to the pump. The temperature difference from the ambient RHR piping temperature to the RCS temperature was approximately 240 to 250 degrees Fahrenheit (DEGF). TVA considers that this event would not occur, during a design basis accident, when the plant was in Mode 1, 2, or 3, since the water initially supplied to the RHR pump during the injection mode of cooling would come from the refueling water storage tank which is maintained between 60 and 105 DEGF and would not introduce a 240 to 250 DEGF step transient to the suction of the RHR pumps. Additionally, TVA believes that during the recirculation mode of cooling, the water supply from the containment sump would be at a low enough temperature that this event would not have occurred since the temperature transient would not be as severe.

However, the WBN Technical Specifications require only one train of RHR to be operable in Mode 4. Had this event occurred while operating under these conditions, it would have resulted in the loss of the required operable train of RHR.

CAUSE OF THE DEFICIENCY

TVA determined that the following were possible causes for these events:

1) Voids in the pump during an increase in flow coupled with a rapid thermal transient caused a loss of hydraulic centering forces in the area of the upper casing ring resulting in or contributing to seizure of the impeller to the casing ring.

   For this possible cause, incomplete venting of the system caused the introduction of voids into the RHR heat exchanger and miniflow lines (high points of the system). When the pump was started on miniflow, the now entrained air was pulled into the pump suction and was continuously recirculated through the pump, heat exchanger, and miniflow lines. The recirculation mode also caused the pump to cool down to ambient temperatures. As the discharge valves were opened, the 350 DEGF water from the RCS was pulled through the suction strainer where the differential pressure across the strainer, the increased flow rates, and the elevated temperature potentially caused the air/gasses to be stripped out of solution.

   The entrained voids and potentially stripped air/gasses then entered the pump suction. The rapid increase in temperature through the pump caused the impeller to expand at a much faster rate than the upper casing ring causing the upper casing ring gap to be at a minimum. (Note: calculations by TVA showed the upper casing ring gap could be as small as .002 inch radially.) The voids reaching the upper casing ring resulted in a loss of the hydraulic centering forces on the upper part of the impeller. This coupled with the decreased upper casing ring gap caused the impeller to rub the upper casing ring which resulted in the friction welding of the impeller to the upper casing ring. TVA considers this to be the most probable cause of the event. Westinghouse and the Ingersoll Dresser Pump Company also consider this to be the most probable cause.

2) Deflection/warpage of the stuffing box extension (bell shaped), coupled with a thermal transient, caused the upper casing ring clearance to close resulting in or contributing to seizure of the impeller to the upper casing ring.

   For this possible cause, the stuffing box extension was found to be deflected in the upward direction (bell shaped). The Ingersoll-Dresser Pump Company determined that this deflection could result in the casing ring bore collapsing by approximately .007 inch diametrically at its upper edge, when the flange bolts were torqued. Therefore, during a thermal transient the potential existed for the gap to close with or without voiding in the system.

   TVA could not determine if warping of the stuffing box extension existed before either of these events. However, Westinghouse and the

Ingersoll Dresser Pump company stated that they do not consider this to be a cause of the events.

3) Movement between the pump shaft and the stuffing box extension caused the upper casing ring to impeller clearance to narrow. This, coupled with thermal transient and voids in the system, resulted in or contributed to seizure of the impeller to the upper casing ring.

This contributor is similar to the first possible cause, discussed previously, except that it also includes misalignment of the pump shaft with respect to the stuffing box extension. Under a similar scenario as described above, this misalignment would further reduce the gap between the impeller and the upper casing ring causing a higher probability of seizure.

TVA could not determine if the misalignment occurred prior to the second event. Even though careful measurements were taken for concentricity of the stuffing box extension around the pump shaft following the first failure, TVA could not prove that the misalignment did not occur when the motor was shifted to the upright position prior to placing it in the pump casing.

TVA considers the first possible cause to be the most probable cause of the events, since the out of tolerance conditions discussed in the second and third possible causes could not be proven to have existed prior to the second event. However, if the out of tolerance conditions did exist prior to one or both of these events then the possibility exists that these conditions could have caused, or as a minimum, contributed to the pump failures. In order to prevent recurrence, TVA's corrective actions will address the three possible causes described above.

CORRECTIVE ACTIONS

The following corrective actions are being (or have been) taken to address these events:

1) Plant temporary operating procedures have been revised to include steps for improving the filling and venting process for the RHR system. Similar revisions will be made to permanent plant operating procedures by October 15, 1994.

2) The pump seal heat exchanger vent will be modified to facilitate the venting process by October 15, 1994.

3) A new stuffing box extension and motor support stand have been installed and machining of the pump casing completed. These actions address out of tolerance conditions associated with the motor support stand to stuffing box extension fit and the stuffing box extension to pump casing fit. In addition, motor to motor support stand bolts have been replaced and strengthened to provide for a higher torque value.

4) The required plant procedures will be revised by October 15, 1994, to increase the material strength and torque values of the motor to motor mount bolts.

5) During pump reassembly, appropriate clearances were checked with the pump in the horizontal and vertical positions to ensure that no misalignment occurred during the reassembly process. In addition, the clearance between the impeller and upper casing ring was maximized during the pump reassembly.

6) RHR Pump 1A-A will be rebuilt at the next availability consistent with the site testing schedule. As part of this action, TVA will collect as found data related to this event and ensure that pump tolerances are within specifications. TVA expects this corrective action to be completed by October 15, 1994.

7) TVA will retest the potential operational configurations, for RHR Pump 1B-B, at hot RCS conditions to demonstrate proper pump operation. This retest will be performed during the upcoming mini-hot functional test and is expected to be completed by February 28, 1995.

ENCLOSURE 2

LIST OF COMMITMENTS

The following commitments are made in Enclosure 1 to this letter:

1) Plant operating procedures will be revised by October 15, 1994, to include steps for venting the RHR system.

2) The pump seal heat exchanger vent will be modified to facilitate the venting process by October 15, 1994.

3) The required plant procedures will be revised by October 15, 1994, to increase the material strength and torque values of the motor to motor mount bolts.

4) RHR Pump 1A-A will be rebuilt at the next availability, to collect as found data related to this event and to ensure that pump tolerances are within specifications. TVA expects this corrective action to be completed by October 15, 1994.

5) TVA will retest the potential operational configurations, for RHR Pump 1B-B, at hot RCS conditions to demonstrate proper pump operation. This retest will be performed during the upcoming mini-hot functional test and is expected to be completed by February 28, 1995.