

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

85 SEP 18 12:06

September 12, 1985

WBRD-50-390/85-25

WBRD-50-391/85-23

U.S. Nuclear Regulatory Commission

Region II

Attn: Dr. J. Nelson Grace, Regional Administrator

101 Marietta Street, NW, Suite 2900

Atlanta, Georgia 30323

Dear Dr. Grace:

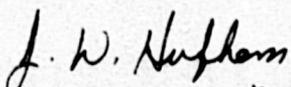
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - FAILURE IN HIGH PRESSURE FIRE PROTECTION PUMP 2B-B - WBRD-50-390/85-25, WBRD-50-391/85-23 - REVISED FINAL REPORT

The subject deficiency was initially reported to NRC-OIE Inspector Al Ignatonis on July 15, 1985 in accordance with 10 CFR 50.55(e) as NCR W-243-P. This was followed by our final report submitted on August 13, 1985. Enclosed is our revised final report.

If you have any questions concerning this matter, please get in touch with R. H. Shell at FTS 858-2688.

Very truly yours,

TENNESSEE VALLEY AUTHORITY



J. W. Hufham, Manager

Licensing and Risk Protection

Enclosure

cc: Mr. James Taylor, Director (Enclosure)  
Office of Inspection and Enforcement  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Records Center (Enclosure)  
Institute of Nuclear Power Operations  
1100 Circle 75 Parkway, Suite 1500  
Atlanta, Georgia 30339

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## ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2  
FAILURE IN HIGH-PRESSURE FIRE PROTECTION PUMP 2B-B  
WBRD-50-390/85-25, WBRD-50-391/85-23  
NCR W-243-P  
10 CFR 50.55(e)  
REVISED FINAL REPORT

### Description of Deficiency

In June 1985 High Pressure Fire Protection Pump 2B-B failed during operation, and maintenance request MR A-539178 was initiated to replace the upper pump bearing of pump 2B-B. In implementing the maintenance request TVA found that the packing gland was broken and the pump shaft was loose. Because of this, the pump was disassembled and inspected which revealed that the top line shaft was broken in one location, that the bottom line shaft was broken in the thread section, that seven of the eight bearing retainers were broken, that all line shaft bearings were destroyed, and that the bowl sections contained some mud and bearing material.

After the nonconformance report (NCR) was written, pump 2A-A was also disassembled and was found to have failed in the same manner as pump 2B-B with the shaft being broken in essentially the same places, the bearing retainers broken, and the line shaft bearings destroyed. However, no significant amount of mud was found in the bowl sections of pump 2A-A. Additionally, TVA found that the pump casings were extended approximately 44-inches below the suction bell for each of the four pumps and that the axial impeller clearance for all pumps was set at a value of 0.075 inch.

An analysis of the failed line shafts performed at TVA's Singleton Laboratory concludes that the pump shaft fractures all occurred by a fatigue mechanism with the upper shaft failing after the lower shaft fracture had taken place. Because the pump bearings are product-lubricated, breakage of the bottom line shaft would cause a loss of coolant for the line shaft bearings, induce their failure and could have subsequently caused the fatigue fracture on the upper shaft. The analysis also rules out any defect in the shaft material as the cause. An inspection of the HPPF pits found no significant silt in either the A or B train pit. Therefore, since the lower shaft failure was a fatigue failure (as opposed to a ductile failure), excess mud and silt have also been ruled out as the primary cause of the failures.

Additional investigation has not determined a single specific root cause, however, possible contributing factors are:

1. The axial impeller clearances being set too low by TVA could cause the shaft to deflect or accelerate wear on the bearings (i.e., the shaft could deflect and wobble if the impellers were dragging or bouncing off the bottom due to improper axial impeller clearance).

2. The pump wells not being installed per TVA design, thus possibly causing cavitation and abnormal hydraulic disturbances in the sump, such as vortexing.
3. Excessive bearing wear. The Singleton Laboratory report indicates that excessive bearing wear could have initiated the lower shaft fatigue failure.

### Safety Implications

In addition to providing fire protection, the HPFP pumps supply feedwater to the steam generators during maximum flood conditions, with two of four pumps being able to supply enough water for fire protection and one of four pumps able to supply feedwater for both units. Because there are indications that the failures could be a common mode problem, TVA is taking the conservative position that multiple pumps could fail to operate simultaneously. Such a simultaneous loss under accident conditions could adversely affect safe operation of the plant.

### Corrective Action

TVA has rebuilt pumps 2B-B and 1B-B with 2B-B receiving all new pump internals and bowl assembly and with 1B-B receiving new line shaft bearings, impellers, one new wear ring, and one new pump bushing. Both pumps had the well extensions cut to the proper elevation and impeller clearances set to the manufacturer's recommended clearance of 3/16-inch. They were then tested and showed significant improvement in performance. Both pumps are now in service.

Pump 1A-A was tested for signs of abnormal startup and shutdown transients, high amp readings, and abnormal vibrations at the motor bearings with no abnormalities detected. This pump, as well as pump 2A-A, has been disassembled, and both are scheduled to be rebuilt with replacement parts as necessary by October 15, 1985, contingent on the receipt of spare parts from the vendor. However, if scheduling of the work to support unit 1 fuel loading becomes a critical factor, additional measures will be taken to assure that one of the two pumps will be repaired and be in service to meet the fuel load date.

Both HPFP pit floors were inspected, and the pump well casing extensions and seismic supports for all four pumps were removed to put them in compliance with existing design drawings.

TVA has also added a note to drawing D2081 for contract 76K35-83224 to specify the 3/16-inch clearance as recommended by the manufacturer. This has been completed under engineering change notice (ECN) 5828. Also, the Watts Bar Nuclear Plant (WBN) Maintenance Instruction MI-26.22, "High Pressure Fire Protection Pump Disassembly and Reassembly," will be updated to include the latest manufacturer's recommendations by November 30, 1985.

Additionally, a preventive maintenance program is being developed to ensure that excessive wear on the bearings is much less likely to occur. This program will be developed and documented by November 30, 1985. To support the development of this program, a contract is being established with a vibration analysis company to further evaluate the pumps and make program recommendations.