

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

August 13, 1985

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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 - 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. Enclosed is our 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. A. Damer
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)
FINAL REPORT

Description of Deficiency

During maintenance activities to replace the upper pump bearing of high-pressure fire protection (HPFP) pump 2B-B, 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 all bearing retainers were broken, that all line shaft bearings were destroyed, and that the bowl sections were full of mud.

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 too long for each of the four pumps and that the axial impeller clearance for both pumps were set at a value lower than the minimum clearance of 3/16-inch (0.1875) specified by the vendor's instruction manual.

An analysis of the failed lineshafts performed at TVA's Singleton Laboratory conclude 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 HPFP pits found no significant silt in the B train pit. Therefore, since the lower shaft failure was a fatigue failure (as opposed to a ductile failure), mud and silt have also been ruled out as a 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. The presence of excessive line shaft bearing wear. The Singleton Laboratory report indicates that this excessive line shaft 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 was then disassembled and inspected and will be rebuilt with replacement parts as necessary and tested by September 4, 1985. Pump 2A-A has been disassembled and will be repaired by August 22, 1985.

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.

To prevent a recurrence of this condition, TVA is adding a note to drawing D2081 for contract 76K35-83224 to specify the 3/16-inch minimum clearance recommended by the manufacturer. This will be done under engineering change notice (ECN) 5828 by August 22, 1985. Also, the Watts Bar Nuclear Plant (WEN) Maintenance Instruction MI-26.22, "High Pressure Fire Protection Pump Disassembly and Reassembly," will be updated to include the latest manufacturer's recommendations.

Additionally, a preventive maintenance program is being developed to ensure that excessive wear on the line shaft bearings is much less likely to occur. This program will be developed and documented by November 31, 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.