

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

WBRD-50-390/86-30

SEP 5 1986

86 SEP 12 P 1: 58

U.S. Nuclear Regulatory Commission  
Region II  
Attention: Dr. J. Nelson Grace, Regional Administrator  
101 Marietta Street, NW, Suite 2900  
Atlanta, Georgia 30323

Dear Dr. Grace:

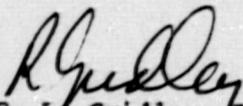
WATTS BAR NUCLEAR PLANT UNIT 1 - LIMITORQUE WORM SHAFT CLUTCH GEAR FAILURE -  
WBRD-50-390/86-30 - FINAL REPORT

The subject deficiency was initially reported to NRC-Region II Inspector Bob Carroll on January 24, 1986, in accordance with 10 CFR 50.55(e) as NCR W-329-P. Our interim report was submitted on March 7, 1986. Enclosed is our final report. We consider 10 CFR Part 21 applicable to this deficiency.

If there are any questions, please get in touch with J. A. McDonald at (615) 365-8527.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

  
R. L. Gridley, Director  
Nuclear Safety and Licensing

Enclosure  
cc (Enclosure):

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

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

B609190249 B60905  
PDR ADOCK 05000390  
S PDR

IE27  
11  
IE09

ENCLOSURE  
WATTS BAR NUCLEAR PLANT UNIT 1  
FAILURE OF A LIMITORQUE WORM SHAFT CLUTCH GEAR  
WBRD-50-390/86-30  
NCR W-329-P  
10 CFR 50.55(e)  
FINAL REPORT

Description of Deficiency

Safety injection system cold leg injection line isolation valve 1-FCV-63-94 was found to have a worm shaft clutch gear failure in its associated motor operator. The failed motor operator is a model SBD-2 manufactured by Limitorque Corporation, Lynchburg, Virginia, and provided to TVA by Westinghouse as part of the NSSS contract for Watts Bar Nuclear Plant (WBN). Limitorque notified NRC in F. K. Denham's August 13, 1985 letter to NRC-OIE that this type of failure is possible in any size 2 Limitorque motor operator type SMB, SB, or SBD when it is combined with a two-pole ac motor (3600 r/min at 60 Hz) or a dc motor using an actuator ratio less than 55.84:1. In such high stem speed applications, the worm shaft clutch gear is prone to impact overload failure when the motor operator is energized after having been manually operated by means of the handwheel. Limitorque reports a four-percent failure rate in candidate motor operators shipped in the past 12 years. TVA has previously experienced failures of this type at Browns Ferry Nuclear Plant (BFN). Other potentially affected motor operators are also installed at WBN.

Based on the results of a failure analysis performed by the TVA Nuclear Central Office Component and Metallurgical groups and information obtained from Limitorque, the failure of the worm shaft clutch gear was determined to be as follows: (1) gear material was type AISI 4140 steel which is an adequate gear material when properly heat treated. However, the gear was flame hardened by the manufacturer which resulted in a low toughness of the lugs on the gear, and (2) unacceptably high design impact loading of the clutch gear lugs when returning to motor operation from manual operation.

Limitorque has identified the high impact loading as an adequate failure mechanism regardless of gear material properties, as evidenced by failures of acceptable gear material at other plants. TVA considers that the combination of the low toughness of the gear lugs and high design impact loading of the clutch gear caused the subject failure.

After an investigation of similar failures at BFN, TVA concurs with Limitorque's notification that the unacceptable high impact loading is limited to size 2 actuators utilizing either a two-pole ac motor (3600 rev/min @ 60 Hz, 3000 rev/min at 50 Hz) or a dc motor. However, TVA findings indicate a worm shaft clutch gear to motor pinion gear ratio of less than 1.69:1 is more accurate than the actuator ratio that was suggested by Limitorque.

Safety Implications

If the failed clutch gear on valve 1-FCV-63-94 had remained uncorrected, remote control operation of the valve could not be achieved. The function of the valve is to provide isolation of the residual heat removal pumps from the

reactor coolant system cold leg after a loss of coolant accident (LOCA). This isolation allows the initiation of hot leg recirculation which is utilized for the prevention of boron precipitation in a post-LOCA situation.

Because the valve would be located in a harsh post-LOCA environment due to radiation levels, manual operation could also be lost in the event of a LOCA. Consequently, successful initiation of hot leg recirculation could be prevented. This could adversely impact the safety of operations of the plant.

#### Corrective Action

TVA will perform the modifications noted below to valve 1-FCV-63-94 to correct the identified deficiency. Also, TVA has identified the following valves at WBN that are subject to high impact loading:

- 1,2-FCV-2-205 (nonsafety related)
- 1,2-FCV-2-211 (nonsafety related)
- 1,2-FCV-63-1 (safety related)
- 1,2-FCV-63-93 (safety related)
- 1,2-FCV-63-94 (safety related, subject gear failure occurred in 1-FCV-63-94)
- 1,2-FCV-74-3 (safety related)
- 1,2-FCV-74-21 (safety related)

These valves will be similarly modified to prevent a recurrence of the failure identified on 1-FCV-63-94. The following six valves will also be subject to the same modifications since they have size 2 actuators with 3600 rev/min ac motors:

- 1,2-FCV-2-128 (nonsafety related)
- 1,2-FCV-2-147 (nonsafety related)
- 1,2-FCV-2-167 (nonsafety related)

In order to eliminate the engagement of the clutch gear lugs under high speed and high inertia conditions, the clutch trippers in the above listed valves will be permanently removed. This action is recommended by Limatorque and will be documented by existing plant administrative requirements. This modification will not alter the performance of the actuator except to require the declutch lever to be held down continually during manual operation. Information tags will be attached to each affected valve to indicate the modification which was performed and the resulting requirement for manual operation. TVA will also replace the worm shaft clutch gear, worm shaft clutch, and motor pinion gear on all of the identified valves with new parts supplied by Limatorque that possess acceptable material properties. Thus, by both reducing the impact loads applied to the clutch lugs and installing components with significantly improved material properties, TVA, with concurrence from Limatorque, considers the existing failure mechanisms will be eliminated. This will ensure that the affected valves will operate and function as designed.

Since the time of original actuator assembly, Limitorque has changed both the material and heat treatment procedure used in the manufacture of the size 2 actuator worm shaft clutch gears and motor pinion gears. The new material is AISI 8620, which is batch hardened to provide a wear resistant surface while maintaining internal ductility for impact resistance. TVA has nonconformed all applicable gears and clutches which are presently stocked as spare parts at WBN and which were fabricated before these revisions to Limitorque's material and heat treatment requirements. These spare parts will be removed from stock as soon as replacements which meet Limitorque's new criteria can be obtained. Additionally, TVA will revise WBN Maintenance Instruction MI-0.16.6 to include a requirement to inspect the worm shaft clutch gears whenever a size 2 Limitorque actuator (utilizing a two-pole ac motor (3600 rev/min) or a dc motor) is disassembled for maintenance. TVA deems these actions, combined with the above-stated corrective actions, to be adequate to prevent a recurrence of the subject failure.

All necessary corrective actions for this item will be completed before initial fuel loading for WBN units 1 and 2, respectively.