

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

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NOV 02 1987

WBRD-50-390/86-64
WBRD-50-391/87-22

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)
Tennessee Valley Authority)

Docket Nos. 50-390
50-391

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2 - FAILED MOTOR PINION KEYS AND
MOTOR SHAFT IN LIMITORQUE OPERATOR - WBRD-50-390/86-64 AND WBRD-50-391/87-22 -
THIRD INTERIM REPORT

The subject deficiency was initially reported to NRC Region II Inspector
Morris Branch on October 9, 1986, in accordance with 10 CFR 50.55(e) as NCR
W-477-P for unit 1. NCR was subsequently superseded by CAQR WBP 870995, and
CAQR WBP 870996 was initiated to document the deficiency for unit 2.
Our first interim report was submitted on November 12, 1986. Enclosed is our
third interim report. We expect to submit our next report on or about
May 2, 1988. We consider 10 CFR part 21 applicable to this deficiency.

If there are any questions, please telephone R. D. Schulz at (615) 365-8527.

Very truly yours,

TENNESSEE VALLEY AUTHORITY


R. Gridley, Director
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Regulatory Affairs

Enclosure
cc: See page 2

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ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
FAILED MOTOR PINION KEYS AND MOTOR
SHAFT IN LIMITORQUE OPERATOR
WBRD-50-390/86-64 AND WBRD-50-391/87-22
CAQRS WBP 870995 AND WBP 870996
10 CFR 50.55(e)

THIRD INTERIM REPORT

Description of Deficiency

During preventive maintenance for the actuator on valve 1-FCV-63-72A (residual heat removal (RHR) pump suction to containment sump isolation valve), the motor shaft-pinion gear key connection was found to be damaged. The key was found deformed and approximately one third of the way out of its slot. The motor shaft was found to be cracked in two places. The redundant train valve actuator (1-FCV-63-73B) was then examined, which revealed a similarly deformed key, still in complete engagement with no motor shaft cracking. The failed actuators are model SB-3, manufactured by Limitorque Corporation, Lynchburg, Virginia, equipped with 100 foot-pound force (ft-lb) motors. These were provided to TVA by Westinghouse Corporation, Pittsburgh, Pennsylvania, under the NSSS contract (54114-1). These are the only two size 3 actuators with 100 ft-lb motors used in safety-related applications for each unit as WBN.

Safety Implications

The damage identified could result in a sudden failure of the key and/or motor shaft, rendering the valves inoperable. Failure of these valves to operate could result in loss of the ability to recirculate water from containment following a loss of coolant accident (LOCA). Therefore, this deficiency could have adversely affected the safety of operations of the plant.

Interim Progress

As discussed in our last report dated March 11, 1987, TVA considered further investigation was needed to determine the root cause of the motor shaft failure. Subsequent field investigations into other actuators with similar configurations has revealed an additional cracked shaft, four deformed keys and ten motor shafts with significantly tapered key slots. The attached table summarizes the technical information on the actuators inspected in our investigations.

The following discussion will provide details of the investigation and results of the inspections:

The first course of action was to inspect the two identical valves on our unit 2 (2-FCV-63-72, -73). The inspection revealed a cracked motor shaft (2-FCV-63-72) and key deformation on both valves identical to but slightly less pronounced than those found on the unit 1 valves (1-FCV-63-72, -73). The key and motor shaft materials were determined to be type 1018 steel and type 1144 steel, respectively. Both of the keys were fully engaged with the shaft and gear in addition to the shaft being staked to prevent key to shaft separation. Both of the shafts had visible tapering of the keyway slot (0.012 in. - 0.019 in.).

Also of possible significance is the fit of the pinion gear to the motor shaft. The pinion gear was removable by hand on the valve found with the cracked shaft (2-FCV-63-72), and the gear on 2-FCV-63-73 required a gear puller for removal.

Other size 3 actuators with 100 ft-lb motors that were inspected consisted of two Walworth gate valves and five butterfly valves with H6BC and H7BC operators. Both gate valves (1-FCV-2-221, -224) had significant indentions along both sides of the keys and slight keyway slot tapering (0.004 inch (in.) - 0.008 in.). The key and shaft materials were determined to be type 1018 steel and type 4140 steel, respectively.

The five butterfly valves that were inspected revealed no shaft or key damage. This could be because of low-impact loads associated with quarter turn valves.

Our concern was then directed to those actuators in unit 1 that had previously been retrofitted with keys made of type 4140 steel as a result of IE Bulletin 81-08 in 1982. The valves that were affected on unit 1 consisted of four SB-4s with 300 ft-lb motors, eight SMB-4s with 150 ft-lb motors, four SBD-3s with 150 ft-lb motors, and one SMB-3 with a 150 ft-lb motor. At the time of this retrofit, key replacement was the only task performed and inspection of the motor shaft was not documented.

Of the SBD/SMB-3 actuators with 150 foot-pound motors that were inspected, the SBD-3s were found to have slight marking on the type 4140 steel keys with a noticeable taper on all motor shaft keyway slots of 0.025 in. - 0.030 in. It should be noted that in 1982, the type 1018 steel keys removed from these four valves were deformed with surface cracking similar to those found on the SB-3 actuators with 100 foot-pound motors referenced earlier. The SMB-3 actuator inspected revealed no damage to the key or keyway slot. This is a much slower actuator than the four SBD-3s previously mentioned.

Only one of the SB-4 actuators with 300 foot-pound motors (1-FCV-3-100) was inspected. The motor key showed slight markings on each side, however the motor shaft keyway slot had a noticeable taper (0.015 in. - 0.020 in.). It is assumed the other three valves in this group would be in the same condition. It is unknown if the original type 1018 steel keys were deformed when they were removed.

Of the remaining eight SMB-4 actuators with 150 foot-pound motors, only two were inspected revealing no keyway deformation and no significant taper in the keyway slot. These are much slower geared actuators and it is assumed the shaft keyway loading was much less than in the previously mentioned actuators.

As a result of this investigation, it appeared that the root cause of the motor shaft and key failures was because of inadequate material. A motor shaft and key, both made of type 4140 steel were then installed in 1-FCV-63-72A. The valve was cycled approximately 15 times while performing a MOVATS (Motor-Operated Valve Analysis and Test System) diagnostic test.

The motor was then removed and reinspected. The shaft keyway showed approximately 0.020 in. tapering of the key slot and the key had slight indentions along both sides. Using the MOVATS system, the maximum valve thrust during this test was measured to be approximately 50,000 pounds. This is much less than the maximum design thrust of 140,000 pounds for a size 3 actuator.

As a result of this test, it became evident to TVA that the use of the higher strength 4140 material in the motor shaft and key may not be an acceptable corrective action and further investigation will be required. The root cause of these failures has not yet been adequately defined. It appears to be a design deficiency that cannot be eliminated by simply a change in material specifications.

The Limatorque Corporation has been notified of our findings by letter, numerous telecons, and transmittal of photographs and metallurgical analysis reports. TVA is presently shipping the most recent test motor to the Limatorque Corporation for their analysis and investigation.

TVA expects to provide the next report on this deficiency on or about May 2, 1988, pending the vendor's response and subsequent field verification of the recommended corrective action.

TABLE
ACTUATOR INFORMATION

TVA I.D.	SIZE TYPE	ORDER NO. SERIAL NO.	VALVE MFG. SIZE & TYPE	MOTOR TORQUE NOM. RPM	MATERIAL KEY/SHAFT	CONDITIONS FOUND
1-FCV-63-72A	SB-3	<u>378446N</u> 197102	Westinghouse 18" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 1144	Motor shaft cracked in 2 places Visible keyway slot taper Key badly deformed and found 1/3 way out of keyway slot
1-FCV-63-73B	SB-3	<u>378447N</u> 205062	Westinghouse 18" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 1144	Visible keyway slot taper Key badly deformed
2-FCV-63-72A	SB-3	<u>378446N</u> 197101	Westinghouse 18" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 1144	Motor shaft cracked in 2 places Visible keyway slot taper Key badly deformed
2-FCV-63-73B	SB-3	<u>378447N</u> 205061	Westinghouse 18" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 1144	Visible keyway slot taper Key badly deformed
1-FCV-2-221	SMB-3	<u>387478J</u> 218571	Walworth 24" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 4140	Slight keyway slot tapering (0.004" - .008") Indentions in side of keys
1-FCV-2-224	SMB-3	<u>387478J</u> 218570	Walworth 24" - Gate	<u>100 ft-lb.</u> 3600	<u>1018</u> 4140	Slight keyway slot tapering (0.004" - 0.008") Indentions in side of keys
1-FCV-63-67	SBD-3	<u>378447J</u> 205990	Westinghouse 10" - Gate	<u>150 ft-lb.</u> 3600	<u>4140</u> 1144	Keyway slot tapering (0.025" - 0.030") 4140 key installed in 1982, marked but not deformed

TABLE
ACTUATOR INFORMATION

TVA I.D.	SIZE TYPE	ORDER NO. SERIAL NO.	VALVE MFG. SIZE & TYPE	MOTOR TORQUE NOM. RPM	MATERIAL KEY/SHAFT	CONDITIONS FOUND
1-FCV-63-80	SBD-3	<u>378447J</u> 205987	Westinghouse 10" - Gate	<u>150 ft-lb.</u> 3600	4140 1144	Keyway slot tapering (0.025" - 0.030") 4140 key installed in 1982, marked but not deformed
1-FCV-63-98	SBD-3	<u>378447J</u> 205988	Westinghouse 10" - Gate	<u>150 ft-lb.</u> 3600	4140 1144	Keyway slot tapering (0.025" - 0.030") 4140 key installed in 1982, marked but not deformed
1-FCV-63-118	SBD-3	<u>378446J</u> 197095	Westinghouse 10" - Gate	<u>150 ft-lb.</u> 3600	4140 1144	Keyway slot tapering (0.025" - 0.030") 4140 key installed in 1982, marked but not deformed
1-FCV-3-205	SMB-3	<u>394903E</u> 258673	Walworth 16" - Gate	<u>150 ft-lb.</u> 1800	4140 1144	No keyway slot taper or key damage. 4140 key installed in 1982
1-FCV-3-100	SB-4	<u>3A1783A</u> 264376	Walworth 16" - Gate	<u>300 ft-lb.</u> 3600	4140 1144	Keyway slot tapering (0.015" - 0.020") No key damage 4140 key installed in 1982
1-FCV-3-67	SMB-4	<u>387478S</u> 244441	Walworth 24" - Gate	<u>150 ft-lb.</u> 3600	4140 1144	No significant keyway slot taper No key damage 4140 key installed in 1982
1-FCV-3-81	SMB-4	<u>387478S</u> 244440	Walworth 24" - Gate	<u>150 ft-lb.</u> 3600	4140 1144	No significant keyway slot taper No key damage 4140 key installed in 1982