

Withdrawn

NRC Information Notice 2008-09, "Turbine-Driven Auxiliary Feedwater Pump Bearing Issues," dated May 22, 2008 (ADAMS Accession No. ML080780091), has been withdrawn and superseded by RIS 2002-12B Rev. 1 (ADAMS Accession No. ML11189A079).

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

May 22, 2008

NRC INFORMATION NOTICE 2008-09: TURBINE-DRIVEN AUXILIARY FEEDWATER
PUMP BEARING ISSUES

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert licensees to issues with turbine-driven auxiliary feedwater (TDAFW) pumps, as they relate to the importance of having accurate maintenance instructions and effective post-maintenance testing. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

A recent event involving a TDAFW pump resulted in the pump being declared inoperable, which led to a plant shutdown. Inadequate maintenance and post-maintenance testing contributed to this event, which is described below.

TDAFW Pump Bearing Problems at Point Beach Nuclear Plant (Point Beach) Unit 1

On May 1, 2007, at Point Beach Unit 1, during post-maintenance testing of the 1P-29 TDAFW pump following a 10-year overhaul of the turbine, personnel observed oil leaking from the outboard (governor) end of the turbine, at the turbine trip disc housing. Post-maintenance testing was performed utilizing an existing inservice test (IST) procedure which did not require a prolonged run of the TDAFW pump. However, during the testing, high bearing temperature alarms were received, but were not adequately addressed nor evaluated by the licensee's staff. The test was aborted when the reason for the oil leakage could not be determined. Troubleshooting determined that the leakage was the result of inadequate clearance between the journal bearing and the bearing housing. The journal bearing had been replaced as part of the overhaul. The old bearing was reinstalled, and the oil leakage ceased.

On June 9, 2007, the licensee operated the 1P-29 TDAFW pump in accordance with the quarterly IST procedure. During this test, the TDAFW pump turbine outboard bearing reached a

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temperature of 233 °F, which was 8 °F over the bearing high-temperature alarm setpoint of 225 °F (temperatures over 250 °F required the pump to be shut down). Licensee personnel wrote a condition report indicating that the temperature was increasing when the pump was secured from the IST; however, personnel took no immediate actions to address the high bearing temperature, which had not stabilized at the time the pump was secured. On June 11, 2007, licensee personnel reviewed the data from the June 9, 2007, IST and raised the concern that the pump outboard bearing did not appear to have reached an equilibrium temperature. In response to these concerns, the licensee repeated the IST on June 12, 2007. During the test, the turbine outboard bearing temperature reached 249.5 °F, and the operators aborted the test, shut down the TDAFW pump, and declared the pump inoperable. The licensee commenced a shutdown of Unit 1 on June 14, 2007, when it determined that it could not successfully complete the repair and testing of the 1P-29 TDAFW pump within the 72 hours allowed by technical specifications.

The licensee determined that the root cause of the event was that the 10-year overhaul of the 1P-29 TDAFW pump done in April 2007 during a refueling outage followed an inadequate maintenance overhaul procedure. The procedure specified an improper thrust-bearing axial end clearance, an incorrect coupling shim pack stretch, and an incorrect setting for the turbine wheel lap.

The licensee also determined that the post-maintenance testing of the TDAFW pump following the bearing replacement was inadequate in that the run was not long enough for bearing temperature to stabilize, which prevented the identification of equipment performance problems. A change to the American Society of Mechanical Engineers (ASME) Code for Operation and Maintenance of Nuclear Power Plants (OM Code) from ASME Section XI in 1989 resulted in the removal of stabilization criteria from the normal ISTs for safety-related equipment. Although the licensee's administrative procedure for post-maintenance testing requires temperature stabilization for bearing replacements, the procedure had not been consistently used to identify the need to specify temperature stabilization in the prescribed post-maintenance test since the ISTs no longer include this requirement.

During post-maintenance testing on June 23, 2007, the maximum outboard bearing temperature was 226 °F. In response to the NRC inspectors' questions concerning the effects of increased service water temperatures, the licensee performed an operability determination that concluded that the maximum service water temperature would result in a 12.5 °F rise, for a temperature of 238.5 °F. The TDAFW pump was returned to an operable status.

The NRC issued six noncited violations regarding this event, which the agency evaluated as having very low safety significance (Green). An analysis by a vendor and concurrence by the turbine manufacturer concluded that the bearing would have stabilized at a temperature that was acceptable for a 24-hour mission time. NRC Inspection Report 05000266/2007008 and 05000301/2007008, dated August 21, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML072350175), describes this incident.

Examples at Other Plants of Turbine-Driven Auxiliary Feedwater Pump Bearing Problems

In addition to the problem described above, there have been several similar incidents involving TDAFW pumps that demonstrate the need to perform proper maintenance and adequate post-maintenance testing. NRC review of operating experience records identified the following six incidents involving TDAFW pump bearings since 2001:

- (1) At Prairie Island, the TDAFW outboard bearing exceeded the temperature limit during a flow test. The pump was disassembled and it was discovered the inboard bearing was damaged and the outboard bearing was worn. The inboard bearing had been previously installed without the necessary machining. Licensee Event Report (LER) 05000282/2006-02-00, dated August 7, 2006 (ADAMS Accession No. ML062200215), describes this incident.
- (2) At Millstone, white smoke was observed coming from the TDAFW pump outboard bearing housing vent during surveillance testing. Subsequent inspection found that the thrust bearing had failed. The root cause of the bearing failure was overloading as a consequence of balance drum/sleeve damage caused by balance drum/sleeve misalignment. The damage had progressed to the point that overloading of the thrust bearing occurred with resultant bearing failure. LER 05000336/2006-003-00, dated May 31, 2006 (ADAMS Accession No. ML061640262), describes this incident.
- (3) At Turkey Point, the "B" auxiliary feedwater pump was inoperable because of an incorrectly installed bearing. NRC Inspection Report 05000250/2006010 and 05000251/2006010, dated April 17, 2006 (ADAMS Accession No. ML061090107), describes this incident.
- (4) At Callaway, post-maintenance testing was not adequate to identify degraded TDAFW pump bearing cooling following maintenance. An obstruction in the lube oil cooler caused elevated bearing temperatures. The lube oil filter had been improperly installed during the turbine overhaul, allowing particulate material to bypass the filter. NRC Inspection Report 05000483/2004005, dated February 10, 2005 (ADAMS Accession No. ML050410114), describes this incident.
- (5) At Beaver Valley, a TDAFW pump critical operational parameter (turbine bearing oil reservoir level) was not properly controlled. This condition could have resulted in inadequate oil lubrication to the turbine bearing and an increase in plant risk as the result of the eventual unavailability of the TDAFW pump. NRC Inspection Report 05000334/2002005 and 05000412/2002005, dated July 25, 2002 (ADAMS Accession No. ML022080002), describes this incident.
- (6) At Calvert Cliffs, workers did not correctly follow maintenance instructions during reassembly of the TDAFW pump turbine bearing, which resulted in loss of lubrication and subsequent bearing failure. NRC Inspection Report 05000317/2001-009, dated August 24, 2001 (ADAMS Accession No. ML012360493), describes this incident.

BACKGROUND

The staff has identified the following related INs:

- (1) IN 1981-024, "Auxiliary Feed Pump Turbine Bearing Failures," dated August 5, 1981: The staff describes the problem of damage to inboard turbine journal bearings because of a failure to maintain oil level within a narrow operating range (approximately ¼-inch) within the 3-inch-long sight glass.
- (2) IN 1994-084, "Air Entrainment in Terry Turbine Lubricating Oil System," dated December 2, 1994: The staff describes several events where the inboard bearing oil level was decreasing while the outboard bearing oil level was increasing during testing of turbine-driven pumps. Air entrainment in the oil caused the problems.
- (3) IN 1997-090, "Use of Nonconservative Acceptance Criteria in Safety-Related Pump Surveillance Tests," dated December 30, 1997: The staff describes examples of inadequacies in surveillance test procedure acceptance criteria that had the potential to result in, and in some cases did result in, the failure of pumps to meet their accident analysis acceptance criteria.
- (4) IN 2001-006, "Centrifugal Charging Pump Thrust Bearing Damage Not Detected Due to Inadequate Assessment of Oil Analysis Results and Selection of Pump Surveillance Points," dated May 11, 2001: The staff discusses how failure to actively investigate trends of condition monitoring data when they deviate from an established baseline may cause a licensee to overlook significant pump degradation undetected by performance testing.

DISCUSSION

The Point Beach Unit 1 event involved the TDAFW pump, which is required to be operable as specified in technical specifications. The pump was rendered inoperable because it was improperly assembled as a result of procedural inadequacies associated with the 10-year overhaul of the pump. The post-maintenance for a bearing replacement was inadequate in that it did not require the TDAFW pump to be operated long enough for the bearing temperature to stabilize, which prevented the identification of equipment performance problems. This event demonstrates the importance for licensees to have accurate and adequate maintenance instructions for plant equipment, and also to have effective post-maintenance testing that will verify that proper maintenance was performed.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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