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Director of Nuclear Reactor Regulation
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U.S. Nuclear Regulatory Commission
Washington, DC 20555

REFERENCE: Docket No. 50-186
University of Missouri Research Reactor
License R-103

SUBJECT: Report as required by T.S. 6.1.h.(2) regarding reactor operation with the regulating blade inoperable for less than 5 minutes

DESCRIPTION

On January 23, 1996, at 0206 the reactor was shutdown by manual scram when the console operator determined that the regulating blade was inoperable. The reactor was shut down because Technical Specification 3.2.a. under Limiting Conditions for Operation (LCO) states, "All control blades, including the regulating blade, shall be operable during reactor operation." The T.S. 1.12 definition of operable states, "A system or component is operable when it is capable of performing its intended function in a normal manner." With the regulating blade drive inoperable, the rod run-ins associated with the regulating blade (<10% withdrawn and rod bottomed), listed under T.S. 3.4.c, were inoperable.

An Electronics Technician investigated the problem with the regulating blade drive and discovered a seized bearing on the gearbox input shaft. The bearing was replaced, the regulating blade drive was installed and tested, and the reactor returned to operation at 0934 the same day. We estimate from the Wide Range Monitor (WRM) chart that the reactor may have operated up to five minutes with the regulating blade drive capability deteriorating prior to the manual shutdown.

ANALYSIS

The regulating blade system is used to automatically control reactor power at a desired power level (normally 10 MW). The blade is constructed of stainless steel and is driven at 40 inches per minute by the regulating drive mechanism. The regulating drive mechanism consists of a drive servomotor, gearbox assembly, and a ball/lead screw arrangement to translate the rotary motion of the motor and gearbox to the linear motion of the regulating blade.

In the automatic mode, the regulating blade controls reactor power by comparing the output of the Wide Range Monitor (Channel 4) with the level on the power schedule potentiometer set by the reactor operator. Any difference between the wide range monitor indication and the potentiometer setting creates a drive signal to the regulating blade drive mechanism. The blade frequently shims to make minor adjustments to maintain power at the desired level in automatic control.

The rod run-ins associated with the regulating blade (< 10% withdrawn and rod bottomed) were inoperable during the short time the reactor operated with the regulating blade drive not operable. This is not in compliance with T.S. 3.4.c. The basis for these rod run-ins is to ensure termination of a transient which, during automatic control, is causing a rapid insertion of the regulating blade.

Investigation of the regulating blade drive indicated the failure was due to a seized bearing on the gearbox input shaft. This bearing had been replaced with one from spare parts inventory on December 27, 1995. Inspection of the bearing revealed that it had seized because the ball retainer or separator had broken. This is an unusual failure mode for roller bearings which normally provide warning of failure (e.g., noise). The surprising element in this case is that the bearing with the shortest time in service had failed, which may indicate that it was defective. The bearing, which had been installed from spare parts inventory, may have lost its original lubricant while in storage. Review of the preventive maintenance procedure for the regulating rod gearbox revealed it does not provide directions for lubrication or replacement of bearings.

The Reactor Manager, Facilities Operations Manager, Chief Electronics Technician and Chief Machinist discussed the bearing failure and the procedural deficiency regarding bearing replacement or lubrication. The decision was made to rebuild the spare gearbox with all new sealed (self-lubricating) bearings and place it in service. The regulating blade drive preventive maintenance procedure was changed to specify that the gearbox be replaced with a rebuilt gearbox every two years. This will limit the operating time for the gearbox bearings to a fraction of their rated life. Each time a gearbox comes off service, it will be rebuilt with new sealed bearings, have its gears and gear train inspected, and be available, as a spare, if needed.

The regulating blade and its associated rod run-in features are not part of the reactor safety system as defined in Technical Specification 1.18. The total reactivity worth of the regulating blade is 0.0017 Δk and is not considered in any safety analysis to contribute to the reactor shutdown margin of at least 0.02 Δk with any one shim blade fully withdrawn (T.S. 3.1.e). When a reactor scram or rod run-in occurs, the regulating blade is automatically shifted to manual control to prevent it from trying to maintain power by shimming.

As previously stated in a Licensee Event Report dated January 26, 1996, regarding a different failure of the regulating blade, the management/engineering staff at the University of Missouri Research Reactor are developing a safety analysis to support a request for a Technical Specification revision that would allow a timely reactor shutdown as an action statement for a failure of the regulating blade. This is consistent with ANSI standards ANS-15.1, Development of Technical Specifications for Research Reactors and ANS-15.18, Administrative Control for Research Reactors where special reports would not be required when a research reactor momentarily operates outside the limiting conditions for operation if prompt remedial action is taken (e.g., a reactor shutdown). This would alleviate the generation of a Licensee Event Report for conditions which do not pose a safety concern for the reactor or the public.

CORRECTIVE ACTION

The control room operator manually scrammed the reactor when the regulating blade drive was determined to be inoperable. The cause of the regulating blade drive failure was determined to be a seized bearing for the gearbox input shaft. The bearing was replaced, the regulating blade drive was tested and returned to operation.

The engineering/management team that reviewed this failure recommended that a spare gearbox be rebuilt to meet original specifications with new sealed bearings. This rebuilt gearbox was installed February 12, 1996. The gearbox removed from service will be rebuilt with new sealed bearings and placed in spare parts inventory. The preventive maintenance procedure for the regulating blade drive now specifies that the regulating blade drive gearbox be changed out every two years and rebuilt.

Sincerely,

Walt A. Meyer Jr.
Reactor Manager

ENDORSEMENT:
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