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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 Technical Specification 6.1.h(2) concerning reactor operation with the regulating blade inoperable for a period of about 10 minutes.

Description

At 0630 on April 26, 1994 (during shift turnover), with the reactor operating at full power in the automatic mode, the shift supervisor noted that the Wide Range (Channel 4) chart was showing a downward trend. The supervisor going off shift suggested that the regulating blade drive was not operating properly to maintain power and investigated the problem. The shift supervisor transferred regulating blade control to manual and monitored steadily decreasing reactor power due to xenon buildup. Manual operation of the regulating blade switch revealed that the regulating blade mechanism motor was responding, but the gearbox shaft was not. The problem was quickly identified to be one loose and one missing set screw in the motor to gearbox coupling. (See Figure 1). Tightening the loose set screw returned the regulating blade to operability. The missing set screw was replaced with a new one. Reactor power was recovered to 10 MW approximately ten minutes later. The regulating blade was inoperable for a total of six to seven minutes as determined from subsequent review of the wide range chart. Reactor operation during this time deviates from Technical Specification 3.2.a. which states, "all control blades, including the regulating blade, shall be operable during reactor operation."

With the regulating blade mechanism inoperable, the rod run-ins associated with the regulating blade (REG ROD < 10% or BOTTOMED) would have been inoperable. This deviates from Technical Specification 3.4.c. which states, "The reactor shall not be operated unless the following rod run-in functions are operable . . . Regulating Blade Position < 10% withdrawn and bottomed."

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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 duty 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.

At 0630, April 26, 1994, with the reactor operating at full power in automatic control, the shift supervisor noted a decreasing power trend on the wide range monitor chart. Shift turnover was in progress at this time and the supervisor going off shift recognized these symptoms as similar to a problem with the regulating blade mechanism on November 4, 1992 (reported to the NRC in an LER dated December 2, 1992). The shift supervisor transferred regulating blade control to manual, while the supervisor going off shift investigated the problem. The shift supervisor monitored reactor power, which was slowly decreasing because of xenon buildup, and was prepared to scram the reactor if the problem could not be quickly corrected.

The regulating blade switch was operated while the supervisor going off shift visually inspected the regulating blade drive mechanism. The problem was quickly identified as one loose and one missing set screw in the motor to gearbox coupling. Tightening the loose screw immediately returned the regulating blade mechanism to operability. The missing set screw was replaced with a new one. Regulating blade operability was tested by exercising the mechanism in the manual mode and verifying proper alarm annunciation at the 60% withdrawn position. The reactor was returned to normal operation at 10 MW about ten minutes later. Review of the wide range chart indicated the reactor operated for a total of six to seven minutes with the regulating blade mechanism inoperable. Reactor operation during this time deviates from Technical Specification 3.2.a. and 3.4.c., as stated above.

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. 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. The basis for the rod run-ins associated with the regulating blade is to ensure termination of a transient which, in automatic operation, is causing a rapid insertion of the regulating blade.

Part of our evaluation included review of the corrective action taken after the previous similar failure on November 4, 1992, to determine why it had not been more effective. At that time the motor shaft was filed to provide flats for better seating of the set screws. Additionally, Loctite compound was used on the screw threads to reduce the potential for the set screws to come loose. Our review of preventive maintenance performed on the regulating blade since that time indicated that a semi-annual preventive maintenance procedure had been performed on the regulating blade and motor gearbox on two occasions, May 24, 1993, and again on December 6, 1993, as scheduled. The preventive maintenance procedure did not include the use of Loctite compound on the set screws when reassembling the motor and gearbox. We believe the past corrective action would have been effective in preventing the latest failure if it had been implemented into the preventive maintenance procedures.

Corrective Action

Immediate corrective action was taken by two shift supervisors who recognized the symptoms as being similar to a previous failure. This immediate action to restore regulating blade operability required tightening of one of two set screws and replacing the second set screw in the motor to gearbox coupling for the regulating blade mechanism.

The preventive maintenance procedures have been revised to specify use of Loctite compound on the set screw threads for regulating blade mechanism maintenance. Additionally, one set screw and the motor shaft have been drilled to accept a pin through the motor shaft to provide a more positive mounting of the coupling to the motor shaft.

Sincerely,

Walt A. Meyer Jr.
Reactor Manager

ENDORSEMENT:
Reviewed and Approved

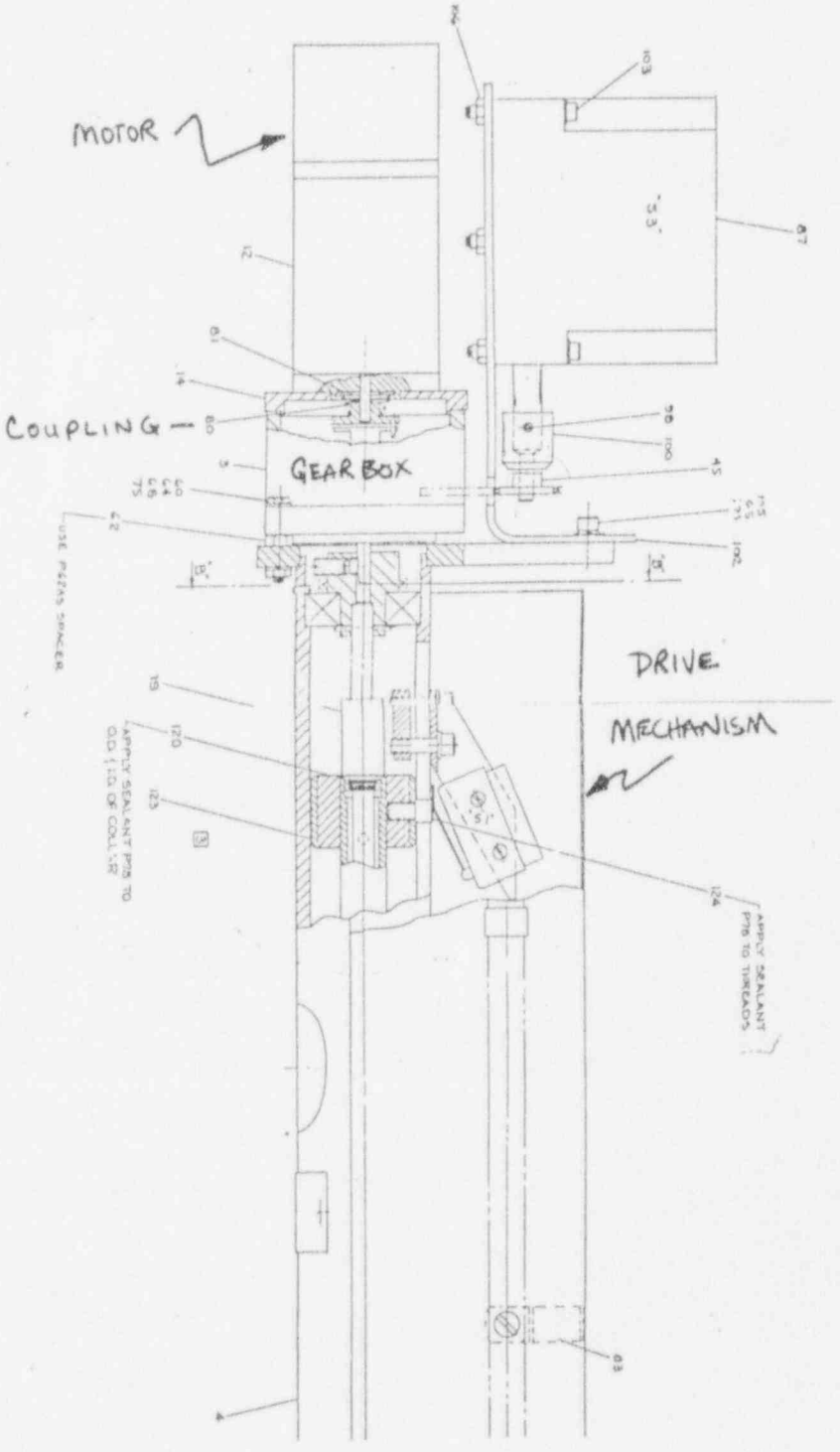
J. Charles McKibben
Associate Director

Christine M. Errante 5/25/94
CHRISTINE M. ERRANTE
NOTARY PUBLIC STATE OF MISSOURI
BOONE COUNTY
MY COMMISSION EXP. APR. 14,1995

Attachment: Figure 1

xc: Mr. Alexander Adams, Jr., USNRC
Regional Administrator, NRC, Region III
Dr. John P. McCormick, Interim Vice Provost for Research
and Graduate School Dean, UMC
Reactor Advisory Committee
Reactor Safety Subcommittee

Figure 1


MOTOR
COUPLING
GEAR BOX
DRIVE
MECHANISM
APPLY SEALANT PTFE TO O.D. (10) OF COLLAR
APPLY SEALANT PTFE TO THREADS