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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 inoperative.

Description:

At 1841 on May 8, 2000, with the reactor operating at full power in the automatic mode, a CHANNEL 4, 5 OR 6 (power ranges) 95% DOWNSCALE annunciator was received. The annunciation locked in. Investigation revealed the regulating blade drive could be driven in but would not drive out. The reactor was shutdown by manual scram at 1843 to be in accordance with Technical Specification (T.S.) 3.2.a., which states, "all control blades, including the regulating blade, shall be operable during reactor operation." 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10% withdrawn and rod bottomed), listed under T.S.3.4.c, were inoperable.

Preceding the failure, the reactor had been in continuous full power operation with the regulating blade properly maintaining power in automatic control for a period of 1 hour 31 minutes on the scheduled maintenance day on May 8, 2000. A review of operations logs and the wide range and power range chart indications verified the operability prior to the failure. The reactor operator manually attempting to shim the regulating blade while another operator monitored the regulating blade drive verified the regulating blade drive could not be driven out and therefore was inoperable.

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 stop it from moving to maintain power by shimming. The basis for the rod run-ins associated with the regulating blade is to assure termination of a transient, which in automatic operation is causing a rapid insertion of the regulating blade.

Analysis:

The regulating blade system is used to automatically control reactor 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.

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In the automatic mode, the regulating blade controls reactor power by comparing the output of the Wide Range Monitor (WRM) with the setting provided by the power schedule potentiometer set by the reactor operator. Any difference between the WRM 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.

When the annunciator alarm was received, immediate inspection of all three power range and WRM charts indicated an actual power decrease starting one minute before the annunciation. The regulating blade was still in automatic control at this time, but the blade was not moving out in response to the difference between the WRM indication and the potentiometer setting. The duty operator then switched the regulating blade control to manual while other operators were inspecting the drive. The regulating blade drive motor was responding but the drive itself could only be operated in the "in" direction. The reactor was shutdown by manual scram at 1843 to repair the regulating blade drive mechanism.

The regulating blade drive gearbox had been installed earlier that day during planned maintenance activities. There is a preventive maintenance (PM) procedure for the regulating blade that requires the gearbox to be changed out every two years and rebuilt. As reported in a letter dated May 5, 2000, the regulating blade gearbox had previously failed on April 7, 2000. At that time the gearbox that had been removed February 7, 2000 due to the two year PM was reinstalled, since this gearbox had performed well for two years. The gearbox that failed and was removed April 7, 2000 was rebuilt. It was installed to allow for rebuilding the other gearbox that had operated for two years and one month.

After the failure on May 8, 2000, the regulating blade drive was removed and the gearbox thoroughly inspected and repaired. Inside this gearbox there are an input and output gear shafts plus one internal gear shafts with two gears on the shaft. One gear is integral to the shaft and the second gear is held in place by a setscrew. The gear held by the setscrew to the internal shaft could be moved around the shaft when sufficient force was applied by hand. The setscrew was not inserted enough to lock into the flat spot on the shaft to keep the gear from turning on the shaft. This allowed enough slippage that the output shaft if held firmly enough could be held stationary while the input shaft was turned. The setscrew for this gear when removed appeared to have had Loctite applied to it. A new setscrew was inserted using Locite insuring the setscrew was inserted into the flat on the shaft. An investigation of the gearbox determined that the setscrew for the main drive gear was tight and holding the gear securely to the output shaft. The gearbox was reassembled and installed into the regulating blade drive mechanism.

The drive was reinstalled and tested over its full range of travel. The regulating blade portion of CP-14 (Regulating Blade 10% and Rod Bottom RRI Rod Not in Contact with Magnet RRI) was completed satisfactorily.

The review of the wide range and power range charts indicated that the reactor had operated for a maximum of four minutes with the regulating blade mechanism inoperable. 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 also 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."

Corrective Action:

The reactor was shutdown by manual scram when it was determined that the regulating blade drive mechanism was not operable. The gearbox was repaired; the regulating blade drive was tested and returned to operation. The operability of the regulating blade and associated rod run-ins and indication was verified. A separate detail procedure has been established for the regulating blade gearbox rebuild.

Sincerely,

J. Charles McKibben
Interim Reactor Manager

Xc: Mr. Alexander Adams, Jr, NRC
Mr. Craig Bassett, NRC

Subscribed and sworn to before me this 7th day of June, 2000.
My commission expires: November 20, 2002.

Brenda Dennis - Notary Public

BRENDA DENNIS
Notary Public-Notary Seal
STATE OF MISSOURI
BOONE COUNTY
My Commission Expires: Nov. 20, 2002