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June 13, 2007

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop P1-37
Washington, D.C. 20555-0001

Reference: Docket Number 50-186
University of Missouri - Columbia Research Reactor
Amended Facility License R-103

Subject: Written communication as required by the University of Missouri Research Reactor Technical Specification 6.1.h (2) regarding a deviation from Technical Specifications 3.2.a and 3.4.c

The attached document provides the University of Missouri Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on May 16, 2007 that resulted in a deviation from MURR Technical Specifications 3.2.a and 3.4.c.

If you have any questions, please contact Leslie P. Foyto, the facility Reactor Manager, at (573) 882-5276.

Sincerely,

Ralph A. Butler, P.E.
Director

RAB/djr

Enc.

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. James S. Coleman, Vice Provost of Research
Mr. Alexander Adams, Jr., U.S. NRC
Mr. Craig Bassett, U.S. NRC

A020
IE22

NRC/NRR

Attachment
US Nuclear Regulatory Commission
June 13, 2007

Licensee Event Report No. 07-01 – May 16, 2007
University of Missouri Research Reactor

Introduction

On May 16, 2007, with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 or 6 Downscale" annunciator alarm was received. This alarm is initiated when any one of three Nuclear Instrumentation (NI) power range monitor (PRM) channels decrease below 95% power. Investigation as to the cause of the alarm revealed that the regulating blade would not function in the inward or outward directions in either the automatic or manual control modes. The reactor was then shutdown by manual scram. Failure of the regulating blade to be operable during reactor operation resulted in a deviation from Technical Specification (TS) 3.2.a, which states, "*All control blades, including the regulating blade, shall be operable during reactor operation.*" Additionally, with the regulating blade in an inoperable state, a deviation from TS 3.4.c had also occurred. TS 3.4.c specifies that the two (2) rod run-in functions associated with the regulating blade must be operable when the reactor is in operation.

Description of Regulating Blade and Drive Mechanism

The reactivity of the reactor is controlled by five neutron-absorbing control blades. Four of the control blades, referred to as the shim blades, are used for coarse adjustments to the neutron density of the reactor core. The fifth control blade is the regulating blade. The low reactivity worth of this blade allows for very fine adjustments in the neutron density in order to maintain the reactor at the desired power level.

The regulating blade is constructed of stainless steel with an overall length of about 30-inches, occupying approximately 18° of the circular arc around the reactor pressure vessel. The blade is driven at 40-inches per minute in both the inward and outward directions by its associated drive mechanism. The regulating blade drive mechanism consists of a servomotor, a reduction gearbox, and a lead screw assembly, which converts the rotating motion of the servomotor to the linear motion of the regulating blade.

The drive mechanism, through a slave gear and chain arrangement, also drives a rod position indication (RPI) encoder transducer and a rotary limit switch assembly. The encoder transducer provides an analog signal to the RPI chassis, which converts the analog signal to a digital readout that is displayed on the control room instrument panel and control console. The rotary limit switch assembly actuates two regulating blade position alarm functions (20% and 60% withdrawn) and a rod run-in ($\leq$10% withdrawn). A second rod run-in is initiated by a limit switch when the regulating blade is fully inserted, or "bottomed."

The regulating blade may be operated from the control console in either one of two modes: manual or automatic. In the automatic control mode, the regulating blade controls reactor power by comparing the output signal from the Wide Range Monitor (WRM) NI with the setting of the

power schedule potentiometer as determined by the reactor operator. If a mismatch does exist, a positive or negative output signal is generated and sent to the servomotor of the regulating blade drive mechanism, which repositions the regulating blade, stepwise, in a direction which minimizes the discrepancy between the power schedule setting and the actual power level. Over the course of the week, while in the automatic control mode, the regulating blade frequently shims to make minor adjustments to maintain power at the desired level.

Detailed Event Description

On May 16, 2007, at 00:29 with the reactor operating at 10 MW in the automatic control mode, a "Channel 4, 5 or 6 Downscale" annunciator alarm was received. This alarm is initiated when any one of three NI PRM channels decrease below 95% power. At that time it was noted by the reactor operator that the regulating blade was at the 14.99-inch withdrawn position and not responding to the decrease in power level. An operator was then sent to the bridge/pool area to visually check the integrity of the regulating blade drive mechanism. Nothing obvious was noted, so it was decided by the Lead Senior Reactor Operator to transfer reactor control from the automatic mode to manual. During manual operation of the regulating blade, it appeared that the servomotor was rotating but the reduction gearbox shaft was not. At this point a manual reactor scram was initiated by the operator because a deviation from TS 3.2.a had occurred. TS 3.2.a states, "*All control blades, including the regulating blade, shall be operable during reactor operation.*" Additionally, with the regulating blade in an inoperable state, a deviation from TS 3.4.c had also occurred. This specification requires that the two (2) rod run-in functions associated with the regulating blade must be operable when the reactor is in operation.

After the reactor was shutdown and secured, the regulating blade drive mechanism was removed and taken to the Electronic Technician Shop for troubleshooting. Upon disassembly, it was discovered that the stainless steel roll pin that connects the servomotor driveshaft to the drive plate had backed out to a point where it was no longer engaged in the driveshaft (Page 5 of 5). In addition, a setscrew, which acts as a secondary means to secure the drive plate to the shaft and is offset approximately 90° from the roll pin, had loosened and backed out also allowing the drive plate to slip on the servomotor driveshaft.

Safety Analysis

Preceding the failure, the reactor had been at continuous full power operation with the regulating blade properly maintaining power level in the automatic control mode for a period of 29 hours and 28 minutes since the last scheduled startup on May 14th. A review of the WRM and PRM strip-chart recorders indicated an actual power decrease starting about four (4) minutes prior to receiving the "Channel 4, 5 or 6 Downscale" annunciator alarm; therefore, it appears that the regulating blade was inoperable for a period of approximately 12 minutes before the reactor was shutdown.

Failure of the regulating blade to be operable during reactor operation resulted in a deviation from TS 3.2.a. The basis for this specification is to ensure that the normal method of reactivity control is used during reactor operation.

Additionally, with the regulating blade in an inoperable state, a deviation from TS 3.4.c had also occurred. The basis for this specification is to ensure that the two (2) rod run-in functions associated with the regulating blade are available to terminate a transient, which in the automatic control mode, is causing a rapid insertion of the regulating blade.

The regulating blade and its associated rod run-in functions are not a part of the reactor safety system as defined in TS 1.18, which states, "*The safety system is that combination of sensing devices, circuits, signal conditioning equipment electronic equipment and electro-mechanical devices that serves to effect a reactor scram, initiate a containment building isolation or activate the primary coolant siphon break system.*" When a reactor scram or rod run-in occurs, the regulating blade is automatically shifted to the manual control mode to prevent it from moving to maintain power.

Corrective Actions

The reactor was shutdown by manual scram when it was established that the regulating blade was inoperable. The stainless steel roll pin, which had backed out of the servomotor driveshaft, was measured using an outside micrometer and determined to be 0.060-inches in diameter. In 1994 and 2000, modifications were performed to the regulating blade drive mechanism where a number of the setscrews in the reduction gearbox and on the servomotor driveshaft were replaced with roll pins. These modifications were corrective actions to a recurring problem where the setscrews would loosen and back out during reactor operation [five regulating blade TS deviations occurred in ten years (1990 to 2000) because of this issue]. The modification specified 1/16-inch (0.0625-inch) diameter roll pins; therefore the one that had backed out was undersized by about 0.0025-inches. A new 1/16-inch roll pin was inserted into the servomotor driveshaft and drive plate, and Loctite adhesive was applied to the setscrew. The drive mechanism was bench tested satisfactorily in the Electronic Technician Shop and then reinstalled and tested over its full range of travel during startup checks.

On January 8, 2007 a routine semi-annual preventative maintenance (PM) activity was performed on the regulating blade drive mechanism, which included the removal of the driveshaft roll pin in order to renew the servomotor spring and nylon washers. In review of the PM procedure, it was noted that the procedure does not specify that the roll pin be replaced each time it is removed. The most probable cause of this event was a failure to renew the roll pin the last time the semi-annual PM was performed. Repeated use of a roll pin causes it to lose its ability to be pressed tightly within a hole; therefore increasing the probability that it will become disengaged from a rotating coupling.

The semi-annual PM procedure has been revised such that the roll pin will be replaced each time it is removed as well as a note to apply Loctite adhesive to the setscrew. A separate biennial PM

procedure is used to rebuild the reduction gearbox. This procedure already specifies that the roll pins will be replaced each time it is disassembled and rebuilt. Additionally, this event has been entered into the MURR Corrective Action Program as CAP entry No. 07-0027 and any additional improvements or corrective actions will be considered.

If there are any questions regarding this LER, please contact me at (573) 882-5276. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Leslie P. Foyto
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

Ralph A. Butler, P.E.
Director

State of Missouri
County of Boone

On this 13th day of June in the year 2007, before me, the undersigned notary public, personally appeared Leslie Foyto & Ralph Butler, known to me to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged that he/she/they executed the same for the purposes therein contained. In witness whereof, I hereunto set my hand and official seal.

Notary Public

Regulating Blade Drive Mechanism