# UNIVERSITY *of* MISSOURI

**RESEARCH REACTOR CENTER**

June 7, 2012

U.S. Nuclear Regulatory Commission
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REFERENCE: Docket No. 50-186
University of Missouri-Columbia Research Reactor
License R-103

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

The attached document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on May 19, 2012 that resulted in a deviation from MURR Technical Specification 3.4.c.

If you have any questions regarding this report, please contact John L. Fruits, the facility Reactor Manager, at (573) 882-5319.

Sincerely,

Ralph A. Butler, P.E.
Director

RAB:djr

Enclosure

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

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NRR

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**Licensee Event Report No. 12-01 – May 19, 2012**
**University of Missouri Research Reactor**

## Introduction

On May 19, 2012, with the reactor operating at 10 MW in the automatic control mode, a Reactor Operator while on routine patrol discovered the drive sprocket for the regulating blade rotary limit switch assembly not rotating during a normal regulating blade movement. The reactor was then immediately shut down by manual scram. The rotary limit switch assembly provides alarm annunciation for regulating blade positions of 20% and 60% withdrawn, as well as providing a rod run-in function at the 10% withdrawn position. Failure of the regulating blade rotary limit switch assembly to be operable during reactor operation resulted in a deviation from Technical Specification (TS) 3.4.c, which states, "*The reactor shall not be operated unless the following rod run-in functions are operable. Each of the rod run-in functions shall have 1/N logic where N is the number of instrument channels required for the corresponding mode of operation.*" The two rod run-in functions associated with "*Regulating Blade Position*" are the "*<10% withdrawn and bottomed.*"

## Description of the 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 approximately 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 (< 10% withdrawn). A second rod run-in is initiated by a limit switch, which is independent of the rotary limit switch assembly, 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) Nuclear Instrumentation 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

At 23:07 on May 19, 2012, during a routine patrol, a Reactor Operator discovered the drive sprocket for the regulating blade rotary limit switch assembly not turning with the associated regulating blade movement. The reactor was immediately shutdown by manual scram due to non-compliance with TS 3.4.c., which states "*The reactor shall not be operated unless the following rod run-in functions are operable. Each of the rod run-in functions shall have 1/N logic where N is the number of instrument channels required for the corresponding mode of operation.*" This specification requires that the two (2) rod run-in functions, <10% withdrawn and bottomed, associated with the regulating blade must be operable when the reactor is in operation.

Upon investigation, it was determined that one of the two setscrews that secure the drive sprocket to the drive shaft of the rotary limit switch assembly had become loose. Additionally, the threads of the second setscrew were galled, thus preventing either setscrew from engaging the drive shaft which allowed the shaft to rotate without rotating the associated drive sprocket.

## Safety Analysis

Proper operation of the regulating blade rotary limit switch assembly is visually verified as part of the reactor operator routine patrol. As required by administrative procedure AP-RO-110, "Conduct of Operations," a routine patrol is performed every four hours when the reactor is operating to record operating parameters of various reactor-related systems throughout the facility as well as verify proper system operation. Therefore, at most, the regulating blade rotary limit switch assembly was inoperable for approximately four hours.

The regulating blade and its associated rod run-in features are not part of the reactor safety system as defined by 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 manual control to prevent it from shimming to maintain power.

The basis for the rod run-in features associated with the regulating blade is to assure termination of a transient which, in automatic operation, is causing a rapid insertion of the regulating rod. The regulating blade <10% withdrawn rod run-in is not required to prevent reaching a Limiting Safety System Setting (LSSS). The redundant regulating blade bottomed rod run-in was operable during the time the <10% withdrawn rod run-in was inoperable.

**Corrective Action**:

The reactor was shut down by manual scram when it was determined that the regulating blade rotary limit switch assembly was inoperable. The lower sprocket with extended shaft was inspected and the regulating blade rotary limit switch assembly drive sprocket and its two associated setscrews were replaced. The applicable sections of compliance procedure CP-14, "Regulating Rod 10% and Rod Bottom Rod Run-In Rod Not in Contact with Magnet Rod Run-In," and the "Regulating Blade Operation And Rod Run-In Function Test" portion of form FM-57, "Long Form Startup Checksheet," were completed satisfactorily to verify proper operation of the regulating blade rotary limit switch assembly.

The regulating blade drive mechanism semi-annual preventative maintenance procedure will also be revised such that all setscrews associated with the regulating blade drive mechanism and position indication system will be inspected and have either threadlock or retaining compound applied on a semi-annual basis. Additionally, this event has been entered into the MURR Corrective Action Program as CAP entry No. 12-0018 and any additional improvements or corrective actions will be considered.

If there are any questions regarding this LER, please contact me at (573) 882-5319. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

John L. Fruits
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

Ralph A. Butler, P.E.
Director

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

MARGEE P. STOUT
My Commission Expires
March 24, 2016
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Commission #12511436