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January 23, 2017

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

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

SUBJECT: Written communication as required by University of Missouri Research Reactor Technical Specification 6.6.c.(3) regarding a deviation from Technical Specification 3.2.f.8.

The attached document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on January 9, 2017, that resulted in a deviation from MURR Technical Specification 3.2.f.8.

If you have any questions regarding this report, please contact Bruce A. Meffert, the facility Reactor Manager, at (573) 882-5118.

Sincerely,

Ralph A. Butler, P.E.
Director

RAB:jlm

Enclosure

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. Hank Foley, Interim Chancellor
Dr. Mark McIntosh, Vice Chancellor for Research, Graduate Studies and Economic Development
Mr. Geoffrey Wertz, U.S. NRC
Mr. Johnny Eads, U.S. NRC

IE22
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NRR

Attachment
U.S. Nuclear Regulatory Commission
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Licensee Event Report No. 17-01 – January 9, 2017
University of Missouri Research Reactor

Introduction

On January 9, 2017, while conducting pre-startup checks on the regulating blade with the reactor operating as defined by Technical Specification (TS) 1.23, "Reactor in Operation," and all four shim control blades fully inserted at a shutdown power level, the expected "REG ROD BOTTOMED ROD RUN-IN" annunciation was not received when the regulating blade was inserted to the bottom end of its travel. This alarm and its associated rod run-in activation should occur when the regulating blade actuates a limit switch at the end of its travel. The duty operator secured the reactor by placing Master Control Switch 1S1 to the "OFF" position thus minimizing the time that MURR deviated from TS 3.2.f.8 that 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. ..... 8. Regulating Blade Position - ≤ 10% withdrawn or bottomed.*" Investigation revealed an intermittent electrical failure in the regulating blade drive mechanism bottom limit switch.

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 about 18° of the circular arc around the outer 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, a lead screw assembly, and an overload clutch. The lead screw assembly 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 bottom 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 Nuclear Instrumentation (NI) Wide Range Monitor (WRM) 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 approximately 11:00 AM on January 9, 2017, while conducting pre-startup checks on the regulating blade with the reactor operating and all four shim control blades fully inserted at a shutdown power level, the expected "REG ROD BOTTOMED ROD RUN-IN" annunciation was not received when the regulating blade was inserted to the bottom end of its travel. This alarm and its associated rod run-in activation should occur when the regulating blade actuates a limit switch at the end of its travel. The duty operator immediately secured the reactor by placing Master Control Switch 1S1 to the "OFF" position thus minimizing the time that MURR deviated from TS 3.2.f.8 that 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. ..... 8. Regulating Blade Position - ≤10% withdrawn or bottomed.*"

After the reactor was secured, the Lead Senior Reactor Operator informed Operations management and the electronics technicians of the problem. Other than placing Master Control Switch 1S1 to the "OFF" position, no other switch or control blade drive manipulations were performed. While the Senior Electronics Technician and the Assistant Reactor Manager-Engineering observed relay 1K4, which activates both the "REG ROD BOTTOMED ROD RUN-IN" annunciation and its associated rod run-in signal, the relay suddenly shifted to the "On" state activating the "REG ROD BOTTOMED ROD RUN-IN" annunciation. Visual inspections of the bottom limit switch and the relay which it activates showed no abnormalities. Wire lead connections at the switch, terminal blocks, and the relay were verified tight. Continued troubleshooting efforts with the reactor secured included running the regulating blade outward and inward to activate the "REG ROD BOTTOMED ROD RUN-IN" annunciation and the relay contacts that energize that annunciation and rod run-in. The relay was cycled multiple times by regulating blade motion with no failure of the annunciation or the relay. In addition, the bottom limit switch was cycled repeatedly manually. Again, no failure of the annunciation or the relay occurred. Discussion between the electronics technicians and Operations management concluded that the mostly likely cause of the intermittent failure was the relay because 1) it is normally only energized once per week during pre-startup tests thus could be stuck due to inactivity, and 2) the limit switch was being positively actuated by the regulating blade and intermittent failure of the limit switch was considered not likely.

Relay 1K4 was replaced with a new relay and the portion of Compliance Procedure-14 (CP-14) which tests the rod run-in functions of the regulating blade and the "Regulating Blade Operation And Rod Run-In Function Test" portion of form FM-57, "Long Form Startup Checksheet," were completed satisfactorily. Permission to start up the reactor was received from the Facility Director. The reactor was started and power increased to 10 MW by the end of the shift.

Later on February 9th, the Reactor Manager was gathering additional information in support of drafting this Licensee Event Report (LER). He discussed more of the event with both the reactor operators on shift and the electronics technicians. Upon further consideration regarding what personnel told him about both the Regulating Rod "Full In" light at the Reactor Control Console and the "REG ROD BOTTOMED ROD RUN-IN" annunciation not being received during the event, the Reactor Manager had some doubt that relay 1K4 replacement fixed the intermittent problem because it was not clear whether the Regulating Rod "Full In" light was actuated by the relay or directly by the regulating blade drive mechanism bottom limit switch. He arranged for a meeting early the next day (February 10th) to review more electrical prints and have additional discussion with the Work Control Manager and electronic technicians. During this meeting, it became apparent that the Regulating Rod "Full In" light was actuated directly from the regulating blade drive mechanism bottom limit switch. Therefore, the Reactor Manager directed that the reactor be shut down and more troubleshooting be focused on the regulating blade drive mechanism bottom limit switch portion of the circuit.

After the reactor was shut down, the portion of CP-14 which tests the rod run-in functions of the regulating blade was performed satisfactorily prior to troubleshooting. Then, the regulating blade drive mechanism was removed to test the bottom limit switch. Continuity tests of the switch showed an intermittent electrical connection issue on the switch terminals. A new switch was installed, and the continuity tests were completed satisfactorily. The regulating blade drive mechanism was reinstalled. The portion of CP-14 which tests the rod run-in functions of the regulating blade and the "Regulating Blade Operation And Rod Run-In Function Test" portion of form FM-57, "Long Form Startup Checksheet," were completed satisfactorily.

Safety Analysis

Preceding the failure, the reactor had been shut down for scheduled maintenance the previous nine (9) hours. Even though the reactor was at a shutdown power level with all four shim control blades fully inserted, failure of the regulating blade rod bottomed rod run-in to be operable during reactor operation as defined by TS 1.23 resulted in a deviation from TS 3.2.f.8. The basis for this specification is to ensure termination of a transient which, in automatic control, is causing a rapid insertion of the regulating blade. There is no indication that the reactor ever operated in automatic control with the regulating rod bottomed rod run-in not working.

The regulating blade and its associated rod run-in features are not part of the reactor safety system as defined by TS 1.24, which states, "*The reactor safety system is that combination of sensing devices, electronic circuits and equipment, signal conditioning equipment, and electro-mechanical devices that serves to either effect a reactor scram, or activates the engineered safety features.*"

Corrective Action:

The reactor was secured by the duty operator upon failure to receive the expected "REG ROD BOTTOMED ROD RUN-IN" annunciation. After two separate troubleshooting efforts, the cause of the intermittent failure of the regulating blade rod run-in was repaired. The portion of CP-14 which tests the rod run-in functions of the regulating blade 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 and its associated rod run-in functions.

Reactor operating procedures will be revised to ensure the reactor is shutdown or secured during the "Regulating Blade Operation And Rod Run-In Function Test" portion of form FM-57, "Long Form Startup Checksheet." It is good operating practice to check regulating blade operation and rod run-in functions prior to reactor startup. However, the reactor does not need to be operating when these checks are performed.

Additionally, this event has been entered into the MURR Corrective Action Program as two separate CAP entries No. 17-0005 and 17-0006. Any additional improvements or corrective actions will be considered and documented in those CAP entries.

If there are any questions regarding this LER, please contact me at (573) 882-5118. I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Bruce A. Meffert
Reactor Manager

ENDORSEMENT:
Reviewed and Approved,

Ralph A. Butler, P.E.
Director

State of Missouri
County of Boone
Subscribed and sworn to before me this 23 day of January 2017
Jacqueline L. Matyas
JACQUELINE L. MATYAS, Notary Public
My Commission Expires: March 26, 2019

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JACQUELINE L. MATYAS
My Commission Expires
March 26, 2019
Howard County
Commission #15634308