University of Missouri

Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211
PHONE 573-882-4211
WEB murr.missouri.edu

November 23, 2021

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
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.6

The enclosed document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that was discovered on November 9, 2021, and resulted in a deviation from MURR Technical Specification 3.2.f.6.

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

Sincerely,

J. David Robertson, PhD
Reactor Facility Director

JDR:jlm

Enclosure

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
Dr. Thomas Spencer, Vice Chancellor for Research and Economic Development
Mr. Geoffrey Wertz, U.S. Nuclear Regulatory Commission
Mr. Craig Bassett, U.S. Nuclear Regulatory Commission

Licensee Event Report No. 21-03 – November 9, 2021
University of Missouri Research Reactor

Introduction

On November 8, 2021, while the reactor was shut down for scheduled routine maintenance and Technical Specification (TS) surveillance testing on the anti-siphon system high level rod run-in instrument channel (level controller LC 965 instrument channel), the surveillance testing provided a measurement greater than the compliance procedure allowed for activation of the anti-siphon system high water level rod rod-in function. However, it was unknown on November 8 if exceeding the compliance procedure limit directly corresponded to a deviation from TS 3.2.f.6 since the procedure instructs a maximum volume of water to be added, and TS 3.2.f.6 specifies a maximum water level above the anti-siphon isolation valves.

The LC 965 instrument channel was restored to normal operation, TS surveillance testing was performed satisfactorily, and the retest was documented in compliance with TS 3.2.f.6. In accordance with TS 6.6.c(4) and before it was known if a deviation from TS 3.2.f.6 had occurred, the Acting Reactor Facility Director was briefed and authorization to restart the reactor was provided prior to returning the reactor to operation later that day.

On November 9, 2021, an engineering evaluation was performed and concluded that the water volume addition needed to activate the anti-siphon system high level rod run-in on November 8 indicated the LC 965 instrument channel deviated from TS 3.2.f.6. TS 3.2.f states, "*The reactor shall not be operated unless the following rod run-in functions are operable*." Specifically, the rod run-in function that occurs when water level in the anti-siphon system is greater than or equal to 6 inches above the anti-siphon isolation valves was not operable as required by TS 3.2.f.6.

Previously on April 22, 2021, the LC 965 instrument channel activated the rod run-in function well below TS 3.2.f.6 maximum requirement. Therefore, sometime between April 22, 2021, and November 8, 2021, the problem developed, and the reactor probably operated while deviating from TS 3.2.f.6.

Description of the LC 965 Instrument Channel

In the MURR Safety Analysis Report (SAR) Section 6.3, Anti-Siphon System, the LC 965 instrument channel sensor is described in the following manner:

"*A level controller, designated LC 965, initiates an "Anti-Siphon Line Hi Level Rod Run-In" annunciator alarm and rod run-in if water level within the anti-siphon system rises to greater than 6-inches (15.2-cm) above the anti-siphon isolation valves. The rod run-in ensures that the introduction of water will not prevent the anti-siphon system from performing its intended function. The level controller is mounted to the end of an aluminum drywell and actuated by a displacer (float) suspended from a stainless steel cable. This arrangement allows the switch housing to be positioned above the surface of the reactor pool, thus preventing the possibility of flooding the switch housing with pool water. The level controller drywell is located adjacent to the reactor pool liner and away from the reactor core and primary coolant system piping to prevent radiation streaming.*"

The LC 965 instrument channel level controller is on the air side of the closed anti-siphon isolation valves 543A and 543B. The air side of the valves is pressurized to 36 psig during primary coolant system operation. A low point drain line and valve is used to blow out excess water from the air side of the valves during startup of the primary coolant system.

Detailed Event Description

On November 8, 2021, while the reactor was shut down and Control Room staff were performing compliance procedure CP-11, "Anti-Siphon High Level Rod Run-in and Low Pressure Alarm," the rod run-in function did not activate until 2.3 gallons of water was added to the air side of the anti-siphon isolation valves. Less than 2 gallons of water is the requirement to satisfactorily pass CP-11. Upon discovery of the out of procedural specification measurement, the Lead Senior Reactor Operator (LSRO) immediately contacted the Reactor Manager.

Troubleshooting revealed the stainless-steel cable that connects the LC 965 instrument channel level controller to its suspended displacer (float) had developed loops in it, effectively shortening the cable. When the primary coolant system pressure side of anti-siphon isolation valves 543A and 543B is greater than the anti-siphon system air side of the valves and then valves 543A and 543B are opened, a water flow surge can move up the level controller LC-965 well and move the displacer (float) up and over its cable. Then, loops or knots can be formed in the cable, effectively shortening the cable and making the amount of water needed to actuate the anti-siphon high water level rod run-in greater than before the water surge. The cable with loops made the rod run-in function activate at a higher water level than when the cable has no loops in it. The loops in the cable were removed, and the LC 965 instrument channel was retested and documented to be back in compliance when only 0.8 gallons of water was required to activate the rod run-in. Though it was known that the CP-11 maximum allowed water volume was exceeded, it was not known whether 2.3 gallons of water caused a deviation from TS 3.2.f.6.

In accordance with TS 6.6.c(4), before it was known if MURR deviated from TS 3.2.f.6, the Acting Reactor Facility Director was briefed, and authorization was provided to restart the reactor prior to the reactor returning to operation later on November 8, 2021.

On November 9, 2021, MURR engineers analyzed the data collected from the November 8 measurement and concluded that prior to removing the loops from the level controller cable, the rod run-in was actuating at a level of approximately 7.3 inches above the anti-siphon isolation valves when 2.3 gallons of water was added, which is greater than the maximum of 6 inches above the valves required by TS 3.2.f.6.

TS 3.2.f states, "*The reactor shall not be operated unless the following rod run-in functions are operable.*" Specifically, the rod run-in function that occurs when water level in the anti-siphon system is greater than or equal to 6 inches above the anti-siphon isolation valves was not operable as required by TS 3.2.f.6. The engineers determined that the TS 3.2.f.6 maximum allowed water level of 6 inches above the valves is equivalent to adding 2.16 gallons of water to the system.

Previously on April 22, 2021, the LC 965 instrument channel activated the rod run-in function at 1.0 gallons of water. Therefore, sometime between April 22, 2021, and November 8, 2021, the displacer (float) cable loops developed, and the reactor probably operated while deviating from TS 3.2.f.6.

Safety Analysis

The basis of the TS 3.2.f.6 limiting condition for operation is to ensure "*...that the introduction of air to the invert loop is sufficiently rapid to prevent a siphoning action following a rupture of the primary coolant piping (Ref. Section 6.3 of the SAR).*"

SAR Section 6.3.2, Design Criteria, states:

"*Two main criteria were considered in the design of the anti-siphon system to prevent the reactor core from becoming uncovered during a rupture in the primary coolant system. The criteria are as follows:*

(1) The entire anti-siphon system must contain a sufficient volume of air to break the siphon should a double-ended primary coolant pipe rupture occur; and

(2) The maximum pressure in the anti-siphon system will be maintained below the operating reactor core pressure to minimize the possibility of air introduction into the primary coolant system should anti-siphon isolation valve leak-by occur."

TS 3.2.f.6 ensures that criterion (1) is met. However, physical system design and procedural controls help ensure that the volume of air in the anti-siphon system meet criterion (1). Water in the system displacing the air volume is the only way to reduce the amount of air volume in the system. The only sources of water into the system are the primary coolant system, via a path past anti-siphon isolation valves 543A and 543B, or water addition due to maintenance activities while the reactor and the primary coolant system are shut down.

When water is introduced into the air side of the anti-siphon system while the primary coolant system is shut down, then the water is removed during the primary coolant system startup section of MURR operating procedure OP-RO-410, "Primary Coolant System." Just prior to withdrawing the control blades (rods) for a reactor startup, MURR operating procedure OP-RO-210, "Reactor Startup – Normal," requires draining water from the anti-siphon system to ensure no water is in the system at reactor startup.

Once the primary coolant system is operating and the anti-siphon system is pressurized to 36 psig, then it is physically impossible for water to leak from the primary coolant system past anti-siphon isolation valves 543A and 543B because the air pressure is maintained at 36 psig and the primary coolant system pressure on the water side of the valves is between approximately 29 psig and 31 psig. Any leakage past the valves adds air to the primary coolant system, not water to the anti-siphon system. MURR has extensive operational experience with leaking anti-siphon isolation valves 543A and 543B, and air always leaks into the primary coolant system.

Finally, MURR form FM-56, "Reactor Routine Patrol," requires operators, during reactor operation, to record and re-pressurize, if needed, anti-siphon system air pressure every four (4) hours to maintain the pressure at 36 psig; drain the anti-siphon system on the first routine patrol of the day; and drain the anti-siphon system on the first routine patrol after reactor startup. Between April 22, 2021, and November 8, 2021, anti-siphon system air pressure remained very close to 36 psig and routine draining of the system showed no water introduction into the system during reactor operation.

In summary, at no time between April 22, 2021, and November 8, 2021, was the anti-siphon system air volume reduced by water entering the system during reactor operation. Therefore, at all times the anti-siphon system had sufficient air volume to perform its function.

Corrective Actions

On November 8, 2021, the LSRO immediately contacted the Reactor Manager when the CP-11 water volume measurement was out of procedural specification.

Troubleshooting revealed the stainless-steel cable that connects the LC 965 instrument channel level controller to its suspended displacer (float) had developed loops in it, effectively shortening the cable. The loops in the cable were removed. The LC 965 instrument channel was retested and documented to be back in CP-11 procedural compliance.

On November 9, 2021, MURR engineers concluded that MURR deviated from TS 3.2.f.6 based on data collected from the November 8, 2021, measurement prior to removing the loops from the level controller cable.

Compliance procedure CP-11, "Anti-Siphon High Level Rod Run-in and Low Pressure Alarm," will be revised to clearly indicate maximum water volume allowed by TS 3.2.f.6 is 2.16 gallons. The procedural maximum water volume will be set at a lower volume than the current 2.0 gallons to provide greater margin to the TS 3.2.f.6 water volume.

Until an engineering solution(s) is implemented, the frequency of checking the LC 965 instrument channel set point will be increased from semi-annually to monthly. In addition, the set point will be checked if it is suspected that the anti-siphon isolation valves opened when primary coolant pressure was higher than anti-siphon system pressure, potentially causing a water surge which could move the displacer (float) over its suspension cable.

MURR Engineering will evaluate potential engineering solutions to prevent the displacer (float) from developing loops in the cable.

Additionally, this event has been entered into the MURR Corrective Action Program as CAP No. 21-0118, and any additional information or corrective actions will be considered and documented in that CAP entry.

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,

J. David Robertson, PhD
Reactor Facility Director

State of Missouri
County of Boone

Subscribed and sworn before me this
23rd day of November, 2021.

JACQUELINE L. MATYAS, Notary Public
My Commission Expires: March 26, 2023

NOTARY PUBLIC NOTARY SEAL STATE OF MISSOURI

JACQUELINE L. MATYAS
My Commission Expires
March 26, 2023
Howard County
Commission #15634308