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October 25, 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.g.6

The enclosed document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that was discovered on October 11, 2021, and resulted in a deviation from MURR Technical Specification 3.2.g.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. 21-02 – October 11, 2021**
**University of Missouri Research Reactor**

## Introduction

On October 11, 2021, while the reactor was shut down for scheduled routine maintenance and Technical Specification (TS) surveillance testing, surveillance testing on reactor core outlet pressure instrument channel 944B (PT 944B instrument channel) revealed the PT 944B instrument channel did not provide a reactor scram at the appropriate TS set point. Upon discovery of the out of specification set point measurement, the Lead Senior Reactor Operator (LSRO) immediately contacted the Reactor Manager. Additional measurements were taken to confirm the PT 944B instrument channel trip set point was below 75 pounds per square inch absolute (psia) and to provide troubleshooting information.

TS 3.2.g states, "*The reactor safety system and the number (N) of associated instrument channels necessary to provide the following scrams shall be operable whenever the reactor is in operation. Each of the safety system functions shall have 1/N logic where N is the number of instrument channels required for the corresponding mode of operation.*" TS 3.2.g.6 requires four (4) primary coolant low pressure instrument channels, which will provide a reactor scram at a trip set point of 75 psia minimum corresponding to pressurizer pressure with normal primary coolant flow.

On October 11, 2021, the PT 944B instrument channel scram set point was calculated to be 74.43 psia, which is slightly below the required 75 psia minimum. Approximately six (6) months earlier on April 12, 2021, the PT 944B instrument channel scram set point was calculated to be 76.94 psia which is within the TS-required set point range. Therefore, at some time between April 12 and October 11, 2021, the reactor possibly operated with the PT 944B instrument channel trip set point below the TS 3.2.g.6-required minimum pressure set point.

Troubleshooting revealed the component in the PT 944B instrument channel that caused the set point deviation. That component was replaced with an exact spare, and the instrument channel was retested and documented to be back in compliance with TS 3.2.g.6. In accordance with TS 6.6.c(4), permission from the Reactor Facility Director was obtained prior to the reactor returning to operation on October 11, 2021.

## Description of the PT 944B Instrument Channel

As described in Sections 7.6.3, Pressure Measurement and Control, and 7.8.3, Anti-Siphon Actuation System, of the MURR Safety Analysis Report (SAR), the PT 944B instrument channel automatically initiates a reactor scram and activates the anti-siphon system upon detecting a low primary coolant system pressure condition.

Primary coolant system pressure is measured at the following locations with the indicated pressure transmitters (PTs) and pressure sensors (PSs):

(a) Reactor Core Outlet - PT 944A & PT 944B; and

(b) Primary Coolant Heat Exchanger Outlet - PT 943.

Primary coolant system pressure is measured at the reactor core outlet near primary coolant isolation valve V507A by PT 944A and PT 944B. The output signal produced by each pressure transmitter is directed to an alarm trip unit. If primary coolant pressure decreases below a predetermined value, a reactor scram is initiated. The alarm trip unit for PT 944A de-energizes relay 2K13, which opens a contact in the process input string to E4A of the Reactor Safety System Non-Coincidence Logic Units (NCLUs), thereby interrupting power to the control blade electromagnets. The alarm trip unit for PT 944B de-energizes relay 2K28, which opens a contact in the process input string to E3B of the NCLUs.

De-energizing either relay 2K13 or 2K28 will also cause the following actions to occur:

1. Primary Coolant Circulation Pumps 501A and 501B will stop;
2. Primary Coolant Isolation Valves V507A and V507B will close;
3. Anti-Siphon System Isolation Valves V543A and V543B will open; and
4. "Reactor Loop Lo Press Scram" annunciator alarm will be initiated.

Primary coolant system pressure is also measured by PT 943 at the point where the outlet piping from the primary coolant heat exchangers converge. The output signal produced by the pressure transmitter is directed to an alarm trip unit. If primary coolant pressure decreases below a predetermined value, a reactor scram and a "Reactor Loop Lo Press Scram" annunciator alarm are initiated. The alarm trip unit for PT 943 opens a contact in the process input string to E3B of the Reactor Safety System NCLUs, thereby interrupting power to the control blade electromagnets. An additional primary coolant system low pressure scram is provided by a pressure sensor (PS 938) which measures pressurizer pressure.

The anti-siphon actuation system functions as a backup system to the various safety instrumentation and equipment (e. g., pressure sensors, pump and valve interlocks, etc.) which ensures that the reactor core does not become uncovered during a Loss of Coolant Accident (LOCA). The system is designed to admit a fixed volume of air to the high point of the reactor outlet piping, or invert loop, instantaneously establishing the pressure in this area at equal to or greater than atmosphere. This prevents a siphon action from being created due to a rupture of the primary coolant piping.

The anti-siphon actuation system is automatically actuated upon detection of primary coolant system low pressure. System pressure is monitored by two electronic pressure transmitters (PT 944A and PT 944B) located on the 12-inch primary coolant piping between the reactor pressure vessel and primary coolant isolation Valve 507A. Should primary coolant system pressure decrease below a predetermined value, PT 944A and PT 944B will de-energize relays 2K13 and 2K28, respectively, either of which will cause the following actions to occur:

1. Reactor will scram - 2K13 will open a contact in the process input string to E4A and 2K28 will open a contact in the process string to E3B of the Reactor Safety System NCLUs;
2. Primary Coolant Circulation Pumps 501A and 501B will stop;
3. Primary Coolant Isolation Valves 507A and 507B will close; and
4. Anti-Siphon System Isolation Valves 543A and 543B will open.

Redundancy is incorporated into the anti-siphon actuation system to ensure that no single component or circuit failure will render any portion of the system inoperative. System reliability is achieved through instrumentation and equipment which fail-safe when de-energized. Characteristics of this system which provide the redundancy and reliability are:

(a) All relays which de-energize to perform their intended function are assumed to be fail-safe;

(b) Redundant primary coolant system pressure monitors PT 944A and PT 944B, either of which will initiate operation of this system are provided; and

(c) Redundant relays 2K13 and 2K28, either of which will initiate operation of this system are provided.

At least two major failures must occur before the anti-siphon actuation system would be unable to perform its intended function. This is not a credible assumption.

**Detailed Event Description**

On October 11, 2021, while the reactor was shut down, Control Room staff were performing compliance procedure CP-22, "Pressure Transmitters PT-944A/B and 943." CP-22 is performed on instrument channels PT 944A, PT 944B, and PT 943 semi-annually to meet the requirement of TS 4.2.j which states, "*The reactor safety system instrument channels listed in Specification 3.2.g shall be channel calibrated on a semiannual basis*." During CP-22, a calibrated pressure source is used as an input to each channel one at a time to perform the calibration. After this 'calibration check' is complete, the 'scram set point check' of CP-22 controls and measures pressurizer pressure with normal primary coolant flow for the purpose of determining at what value of low pressurizer pressure does the associated trip alarm unit cause a reactor scram.

On October 11, the 'calibration check' of CP-22 on the PT 944B instrument channel was satisfactory. However, during the 'scram set point check' for the PT 944B instrument channel, pressurizer pressure had to be lowered to 60.03 pounds per square inch gauge (psig) to initiate the PT 944B instrument channel low pressure trip. Assuming normal atmospheric pressure at MURR's elevation of approximately 600 feet is 14.4 psi, then the PT 944B instrument channel tripped at 74.43 psia which is slightly below the required TS 3.2.g.6 minimum pressure of 75 psia. The LSRO immediately contacted the Reactor Manager about this out-of-specification measurement. The 'scram set point check' was performed an additional two (2) times to verify equipment lineup and consistency of the abnormally low trip set point.

The CP-22 datasheet from the procedure's previous semi-annual performance on April 12, 2021, was reviewed. On April 12, 2021, the PT 944B instrument channel scram trip set point was measured at 62.54 psig at the pressurizer which corresponds to 76.94 psia. Therefore, at some time between April 12 and October 11, 2021, the reactor possibly operated with the PT 944B instrument channel trip set point below the TS 3.2.g.6-required minimum pressure set point. TS 3.2.g states, "*The reactor safety system and the number (N) of associated instrument channels necessary to provide the following scrams shall be operable whenever the reactor is in operation. Each of the safety system functions shall have 1/N logic where N is the number of instrument channels required for the corresponding mode of operation*." TS 3.2.g.6 requires

four (4) primary coolant low pressure instrument channels which will provide a reactor scram at a trip set point of 75 psia corresponding to pressurizer pressure with normal primary coolant flow.

Since the 'calibration check' of the PT 944B instrument channel was satisfactory, troubleshooting focused on the 920H alarm trip unit which is connected in the PT 944B instrument channel 4-20 milliampere (mA) current loop. The 920H alarm trip unit was disconnected from the system and taken to the Instrumentation Support Shop for benchtop testing. A current generator was connected to the trip unit. The 920H alarm trip unit was tripping at 7.55 mA, which is significantly lower than the expected 7.95 mA. This difference of 0.4 mA corresponds almost exactly with the pressure set point decrease from 62.54 psig in April 2021 to 60.03 psig in October 2021. Therefore, the 920H alarm trip change was responsible for change in the overall PT 944B instrument channel low pressure trip set point decrease of approximately 2.5 psi between April and October.

Since the cause of the 920H alarm trip set point change was unknown, it was decided to obtain from the spare parts inventory a new exact replacement alarm trip unit to replace the suspect trip unit to serve as 920H. The spare alarm trip unit was set, and the CP-22 'scram set point check' measured the PT 944B instrument channel trip at 63.81 psig which corresponds to 78.21 psia at the pressurizer, well above the required value of 75 psia. The PT 944 instrument channel was deemed operable. Permission from the Reactor Facility Director was obtained prior to the reactor returning to operation later on October 11, 2021.

**Safety Analysis**

The basis of the TS 3.2.g.6 limiting condition for operation is to ensure the reactor is operated above the pressurizer pressure limiting safety system set point (75 psia) as outlined in TS 2.2. Redundancy is incorporated into the MURR design so that four (4) different primary coolant low pressure safety channels would have to fail to allow the reactor to operate in deviation from the TS 2.2 pressurizer low pressure limit. On October 11, 2021, PT 944B instrument channel was the only primary coolant low pressure safety channel that tripped below the TS-required pressure. On October 11, primary coolant low pressure safety channels PT 944A and PT 943 were tested and found to be operating correctly. Additionally, on July 12, 2021, primary coolant low pressure safety channel PS 938 was tested satisfactorily.

The most conservative assumption is that the PT 944B instrument channel set point was below the TS 3.2.g.6 requirement for the entire six (6) months between April 12 to October 11, 2021. However, during that time, three (3) other primary coolant low pressure safety channels were operable and ensured the reactor maintained a pressurizer pressure above the TS 2.2 limit.

The PT 944A and PT 944B instrument channels also activate the anti-siphon actuation system. Redundancy is incorporated into this system so that either the PT 944A instrument channel or the PT 944B instrument channel can activate the anti-siphon system. During the time period of April to October 2021, PT 944A always tested satisfactorily. Therefore, even though PT 944B instrument channel set point was set too low, PT 944A would have activated the anti-siphon system if a primary coolant low pressure condition occurred.

In summary, at no time was the ability to scram the reactor or activate the anti-siphon system during a primary coolant low pressure event disabled because of redundancies incorporated into reactor design.

**Corrective Actions**

The LSRO immediately contacted the Reactor Manager when the PT 944B instrument channel 'scram set point check' was out of specification. The 'scram set point check' was performed an additional two (2) times to verify equipment lineup and consistency of the abnormally low trip set point.

Troubleshooting revealed that the 920H trip alarm unit in the PT 944B instrument channel was the cause of the instrument channel set point change. The 920H trip alarm unit was replaced with a new spare unit, and the 'scram set point check' of PT 944B instrument channel was retested satisfactorily.

The 920H alarm trip unit that caused the PT 944B instrument channel low pressure set point to change is an Absolute Process Instruments, Inc.(API) 1000G Dual Alarm Trip Unit and was installed in December 2016. The API 1000 series Dual Alarm Trip Units are installed in 10 MURR instrument channels. Seven (7) of the 10 units have been installed since 2006, had no failures, and shown no indications of degradation. Extended bench testing of the suspect alarm trip unit is currently in progress to see if the suspect trip unit holds it set point over the next several months.

Additionally, this event has been entered into the MURR Corrective Action Program as CAP No. 21-0107, 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
25th day of October, 2021.

Jacqueline L Matyas

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