University of Missouri

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

January 12, 2018

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 Specifications 3.4.b and 3.4.a(6)

The attached document provides the University of Missouri-Columbia Research Reactor (MURR) Licensee Event Report (LER) for an event that occurred on December 30, 2017, that resulted in a deviation from MURR Technical Specifications 3.4.b and 3.4.a(6).

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

Sincerely,

Matt Sanford

Matthew R. Sanford
Interim Reactor Facility Director

MRS:jlm

Enclosure

xc: Reactor Advisory Committee
Reactor Safety Subcommittee
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
A020
NRR

Attachment
U.S. Nuclear Regulatory Commission
January 12, 2018

Licensee Event Report No. 17-06 – December 30, 2017
University of Missouri Research Reactor

Introduction

On December 30, 2017, with the reactor operating at 10 MW in the automatic control mode, a Reactor Operator (RO) on routine patrol discovered that the differential pressure gauge in the reactor containment building was indicating zero (0) inches of water vacuum as compared to the laboratory building pressure. The reactor was subsequently scrammed and secured by placing the Master Control Switch (1S1) to the 'OFF' position, thus ending the time that MURR deviated from Technical Specification (TS) 3.4.b, which states, "*Reactor containment integrity shall be maintained at all times except when: (1) The reactor is secured,...*" Reactor containment integrity did not exist because one of its seven (7) requirements was not met. Specifically, TS 3.4.a states, "*For reactor containment integrity to exist, the following conditions shall be satisfied:...(6) The reactor containment building is at a negative pressure of at least 0.25 inches of water with respect to the surrounding areas;...*" Investigation revealed the backup door in the reactor containment building exhaust air plenum had closed, causing a pressure increase in the reactor containment building.

Description of the Backup Doors

As described in Section 6.2.3.4, Supply and Exhaust Ducts, of the MURR Safety Analysis Report (SAR), the supply and exhaust air ducts contain two (2) electric-motor-driven horizontal sliding doors, which are located in the ventilation plenums on the fifth level of the reactor containment building. Actuation of the reactor isolation or facility evacuation system will close these sliding doors sealing off the reactor containment building ventilation flow to the surrounding area. These sliding doors are the primary means of isolating the reactor containment ventilation flow during a reactor isolation or facility evacuation and are part of the containment system.

As described in Section 6.2.4, Backup Doors, of the SAR, a second set of isolation doors, designated the backup doors, are located in the reactor containment building supply and exhaust plenums thereby providing redundancy for reactor containment building isolation. When the backup doors are shut, the steel plenum chamber above the door becomes part of the containment system.

The backup doors are constructed of ¼-inch (0.64-cm) thick metal plate and reinforced to withstand 2.0-psig overpressure (13.8-kPa above atmosphere) (see Figure 1). Each door is held open against gravity by a pneumatic cylinder. Compressed air is supplied to the pneumatic cylinders from the facility main air compressors and the emergency air compressor. A ⅜-inch (0.95-cm) rubber gasket installed in the door facing creates a seal for the backup doors when in the closed position.

The backup doors are normally kept open during reactor operation. A radiation level greater than the set point of either of the reactor bridge radiation monitors, or either of the exhaust plenum radiation monitors, will release air pressure from the cylinders and close both isolation doors automatically. Two solenoid-operated valves, installed in series, control the compressed air supply to each pneumatic cylinder. A closure signal will de-energize both solenoid-operated valves causing air to be vented from the pneumatic cylinder, allowing gravity to close the isolation door. Actuation of either of the solenoid-operated valves will close the backup door.

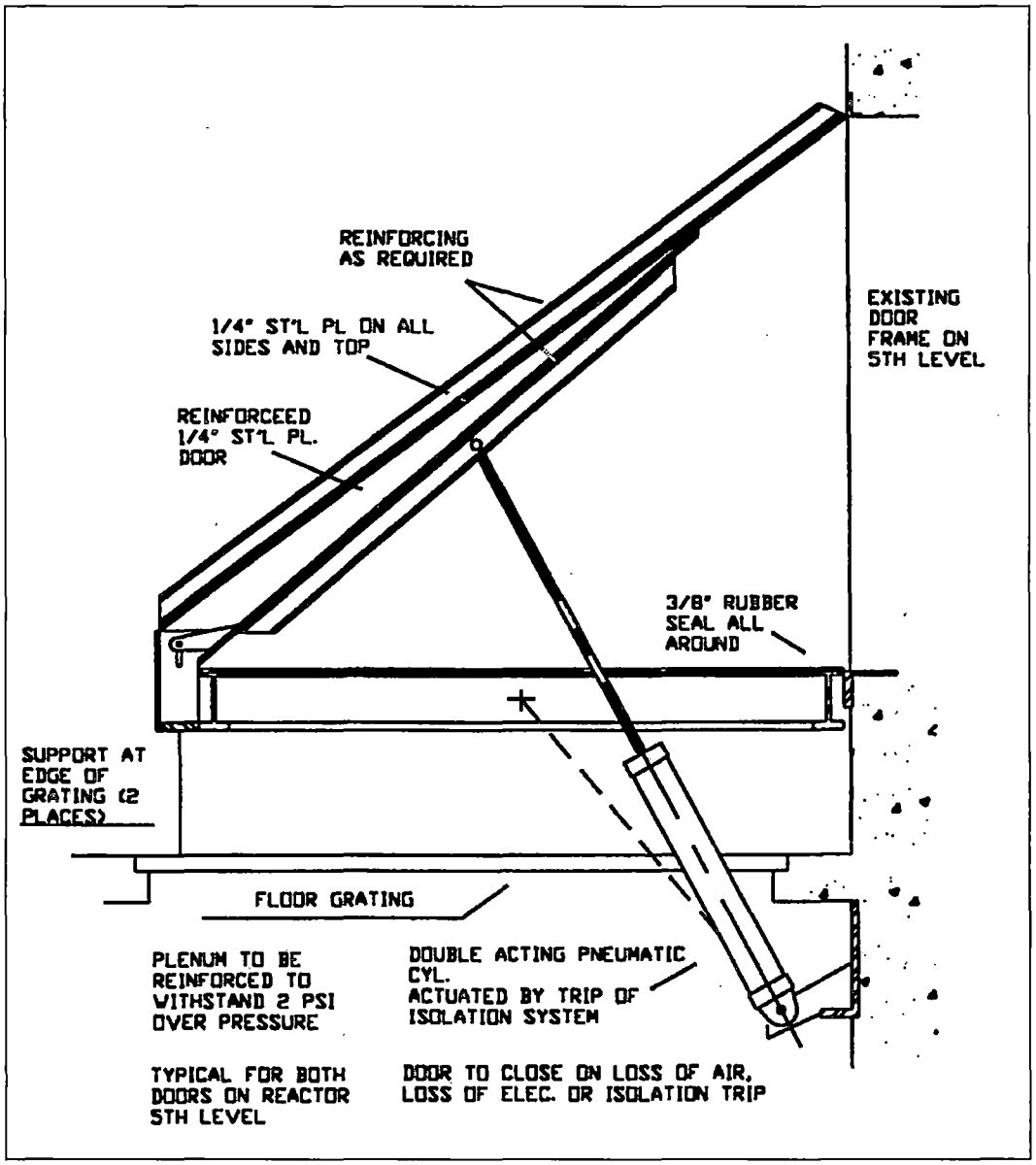

FIGURE 1
BACKUP DOOR

Detailed Event Description

At approximately 06:57 on December 30, 2017, an RO on routine patrol (which is performed approximately every 4 hours) discovered that the differential pressure gauge in the reactor containment building was indicating zero (0) inches of water vacuum as compared to the laboratory building pressure. This pressure reading is required to meet the requirements of surveillance TS 4.4.d, which states, "*When required by Specification 3.4.b, containment integrity shall be verified to exist each shift.*" The RO on patrol immediately radioed the Lead Senior Reactor Operator (LSRO) about this abnormal indication. Since MURR has only one differential pressure indication for reactor containment building pressure, the LSRO directed other personnel to investigate the various components of the reactor containment system to verify whether or not the differential pressure indication was valid. After a few minutes of investigation, the exhaust plenum backup door was found to be closed. Upon hearing the backup door was closed, the LSRO immediately scrammed and secured the reactor at 07:17 by placing the Master Control Switch (1S1) to the 'OFF' position, thus ending the time that MURR deviated from Technical TS 3.4.b, which states, "*Reactor containment integrity shall be mdintained at all times except when: (1) The reactor is secured,...*" Reactor containment integrity did not exist because one of its seven (7) requirements was not met. Specifically, TS 3.4.a states, "*For reactor containment integrity to exist, the following conditions shall be satisfied:...(6) The reactor containment building is at a negative pressure of at least 0.25 inches of water with respect to the surrounding areas:...*"

Closure of the exhaust plenum backup door blocked the path for air to exit the reactor containment building. The supply fan continued to run, and the supply plenum was still open; therefore, air continued to be supplied to the building without air exhausting, which increased pressure in the reactor containment building, thus driving differential pressure to zero (0).

After the reactor was secured, Reactor Operations management directed the LSRO to perform Compliance Procedure-20 (CP-20), which tests the mechanical and electrical portions of the air supply system to the backup door air cylinders. CP-20 satisfies the applicable requirements of surveillance TS 4.4.c. While preparing to conduct CP-20, it was observed that the air actuator of the exhaust plenum backup door would not open the door. In addition, operation of the supply plenum backup door was slower than normal. It was quickly determined that ice had formed in the compressed air supply lines to the backup doors' air cylinders (the temperature in the area surrounding the air supply line to the backup door cylinders was approximately 10 °F that morning). The compressed air supply piping was heated, water was drained from the piping, and electric heat trace with insulation was applied to the piping to prevent freezing of any future moisture in the piping. Operation of the backup doors was tested successfully by completing CP-20 – both backup doors performed normally. As required by TS 6.6.c(4), permission to start up the reactor was received from the Interim Reactor Facility Director. The reactor was started and obtained 10 MW operation at 17:52 on December 30, 2017.

Safety Analysis

As described in Section 6.2.1, Introduction, of the SAR, the containment system is designed to completely isolate the reactor containment building, thereby preventing or mitigating any uncontrolled release of radioactive materials to the environment during an accident. Redundancy is incorporated into the system to ensure that no single component or circuit failure will render any portion of the containment system inoperative. Isolation of the reactor containment building can be automatically initiated by radiation detectors located at the reactor pool upper bridge and in the containment building exhaust plenum. Isolation can be manually activated by switches in the reactor control room or the facility lobby. Actuation of the facility lobby switch will also cause a facility evacuation.

Preceding the discovery that the reactor containment building differential pressure decreased to zero (0) inches of water vacuum, the reactor had been operating at 10 MW in automatic control since December 26, 2017. During a routine patrol occurring between 02:30 and 03:40 on December 30, 2017, prior to the event, an RO logged the containment building differential pressure at 1.50 inches of water vacuum. The operators log the differential pressure approximately every four (4) hours. As stated above, surveillance TS 4.4.d requires reactor containment integrity to be verified to exist within a shift. Since MURR operates on 12-hour shifts, MURR routinely checks containment integrity three (3) times per shift. Therefore, the maximum time in which MURR may have deviated from TS 3.4.b was approximately four (4) hours.

Negative pressure in the reactor containment building compared to the surrounding areas when the reactor is not secured is a TS requirement and good nuclear practice. However, no MURR safety analyses are based on the containment building pressure being negative.

Though the backup door was closed and unable to open due to ice blockage of its compressed air supply line, the reactor isolation and facility evacuation systems were fully operational and capable of isolating the reactor containment building from the surrounding areas. In addition, the air supply lines to all the other components of the reactor containment system are housed inside the building in controlled temperature environments. Therefore, reactor isolation and facility evacuation systems could perform their safety functions as described in the SAR. The backup doors failed to their 'fail safe' position, which is closed.

Corrective Actions

The cause of this event was lower than normal air temperatures surrounding the compressed air piping combined with moisture in the piping. This combination allowed ice to form and slowly block off the air supply to the exhaust plenum backup door air cylinder. As the air pressure slowly bled out of the cylinder, the weight of the door overcame the upward force of the air cylinder, and the exhaust backup door closed. Prior to reactor startup on December 30, 2017, the water was drained from the compressed air lines, and heat trace with insulation was applied to the piping to prevent ice from forming in the lines as a short-term solution. Until the compressed air quality is improved, Reactor Operations staff are also draining condensation for the air supply

piping near the cylinders every week. MURR is currently investigating possible improvements to the main air system to reduce the amount of moisture in the compressed air piping.

If Reactor Operations staff had continuous indication of reactor containment building differential pressure in the Control Room, they may have be able to prevent the deviation of TS 3.4.b by taking action to secure the reactor prior to the negative pressure decreasing below the TS 3.4.a(6) specification of 0.25 inches of water. MURR will be installing a continuous Control Room indication with a low differential pressure alarm in the future. In addition, a Reactor Emergency Procedure will be developed to provide Reactor Operations staff direction in case of a lowering reactor containment building differential pressure.

Additionally, this event has been entered into the MURR Corrective Action Program as CAP Number 17-0149. Any additional improvements 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,

Matthew R. Sanford
Interim Reactor Facility Director

State of Missouri
County of Boone
Subscribed and sworn to before me this 12 day of January 2018
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