Nuclear Reactor Facility

250 West 13th St, Rolla, MO 65409-0450
(573) 341-4236 | reactor@mst.edu | reactor.mst.edu

October 18, 2021

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

SUBJECT: FOLLOW-UP REPORT ON AND RETRACTION OF EN-55509, REPORTED VIOLATION OF MISSOURI S&T REACTOR (R-79) TECHNICAL SPECIFICATION (LIMITING CONDITION OF OPERATION) 3.3.2

Dear Sirs:

The Missouri University of Science and Technology Reactor ("MSTR" with License R-79, Docket No. 50-123) is hereby submitting a written report as a follow-up to our October 5, 2021 phone and email report. Both reports (this written report and the phone/email report) are in regard to the potential MSTR Technical Specification (TS) Violation identified as EN-55509. Follow-up analyses indicate that the facility was not out of compliance with MSTR TS 3.3.2 and that the initial report should be retracted. The attached document details the events, surrounding circumstances, and conclusions supporting this retraction.

If you have any questions regarding this report, please contact either me, at 573-341-4291; or Dr. Joseph Graham, the Reactor Director, at 573-341-7759.

Sincerely,

Ethan Taber
Reactor Manager, MSTR

Joseph Graham, PhD
Reactor Director, MSTR

Enclosure

cc: Radiation Safety Committee (S&T)
Dr. Ayodeji Alajo, Interim Chair of NERS (S&T)
Ms. Paulette Torres, Project Manager (NRC)
Mr. Phillip O'Bryan, Facility Inspector (NRC)

MSTR Licensee Event Report 21-03 Retraction

A maintenance provision of the Missouri University of Science and Technology Reactor (MSTR) Technical Specification (TS) 3.3 was triggered as a result of low reactor pool water resistivity. Demineralizer resins were replaced as part of the correcting maintenance, but it was conservatively assumed and reported to the Nuclear Regulatory Commission (NRC) that the reactor pool resistivity was not able to be restored in the required timeframe. Further review of the available data suggests that the facility remained in compliance with TS 3.3 and that the initial report can be retracted.

Background

The MSTR utilizes a mixed-bed ion exchange (also referred to as deionization, DI, or demineralizer) resin system to maintain pool water quality and resistivity. By minimizing ions present in the water, corrosion of the in-pool components and fuel is also minimized. Further, removing dissolved minerals within the water reduces the overall pool activity and contamination concerns. MSTR TS 3.3(2) specifies the operating requirements of the DI system: "The resistivity of the pool water shall be greater than 0.2 megohm-cm as long as there are fuel elements in the pool. This requirement may be waived for a period of up to 3 weeks once every 3 years."

Per MSTR TS 4.3(1), pool resistivity "shall be measured at least once every 2 weeks when the reactor is operated" (monthly if not operating). The MSTR utilizes an online conductivity cell to actively measure the resistivity of pool water as it exits the DI particulate filter (i.e., prior to the DI bed/tank). An additional cell is present following the DI tank. The readings are displayed on a monitor affixed to the DI tank, and per current facility procedures are checked as part of the Weekly Checklist (and documented) and if the associated alarm annunciator is triggered. Additional readings are recorded (although not required) as part of pool filter replacement and pool water makeup activities. No online recording is performed for the resistivity data.

Through usage, the DI resins become saturated by the ions (which decreases the resins' ability to deionize the water), and a regeneration process involving concentrated hydrochloric acid and sodium hydroxide may be used to strip the ions and restore the resins to a more usable state. This process results in a mixed-hazard (acidic, caustic, and

radioactive) liquid effluent that may be disposed via the sanitary sewer following sampling and analysis and while meeting 10 CFR 20 and other regulatory requirements.

The existing DI system was installed in 1999-2000 as a direct replacement for the MSTR's original configuration. At the time of installation, the regeneration process was suspended indefinitely (although not prohibited) on the grounds of safety (facility personnel would not need to handle large amounts of hydrochloric acid and sodium hydroxide) and "environmental friendliness" (reduced effluent release from the facility). Further, the holdup and mixing tanks needed for this process were removed. In place of regeneration, the most prudent approach determined was to replace the resins once depleted. No facility records indicate that the resins have been replaced (or have needed replacement) since this installation.

A consistent trend has been observed in pool resistivity over periods of reduced or suspended high-power operations. Pool resistivity gradually decreases (over the course of weeks to months) until the reactor is taken to an appreciable percentage of full power for more than a brief time (e.g., 100 kW for two hours). At such a time, pool resistivity is observed to sharply decrease, stabilize, and following shutdown, return to a higher resistivity than prior to startup. No other specific phenomena or mechanisms have been associated with this process, but an example is shown in Figure 1, which follows a period of suspended and restarted operations.

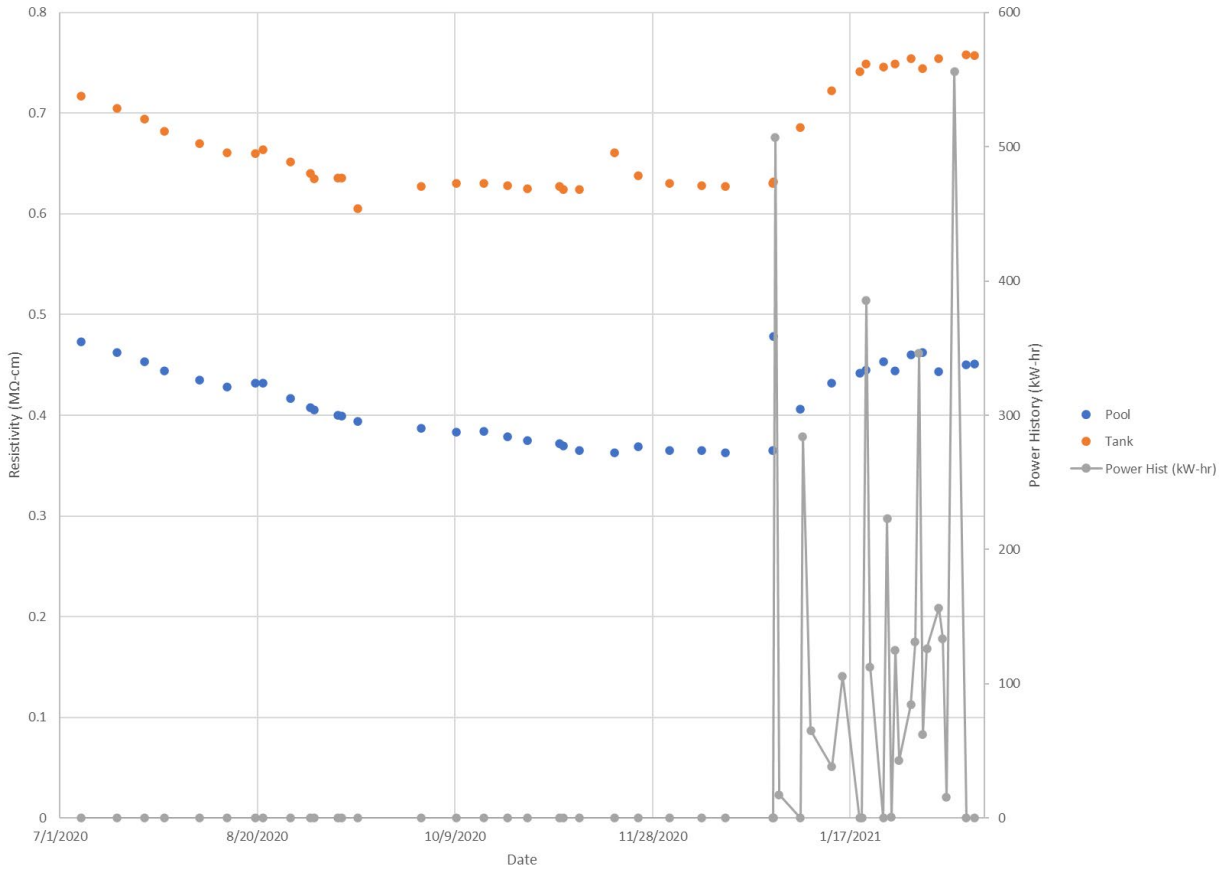

Figure 1 – Historical MSTR Resistivity Data (2H 2020)

Operations at power for the MSTR were minimal between May 2021 and late-August 2021 due to ongoing maintenance in the facility. One of the safety channel detectors required replacement. Additionally, a new magnet and coupling were needed for one of the control rods, requiring some machine work. Given the dropping pool resistivity (following the trending described above), considerations and plans were put into place for the replacement of the resins if the 0.2 MΩ-cm threshold was breached. This included locating a suitable vendor for the resins and reviewing the previous resin removal and installation process (the process used on the tank installation in 2000). The operations history and pool resistivity for this period are displayed in Figure 2.

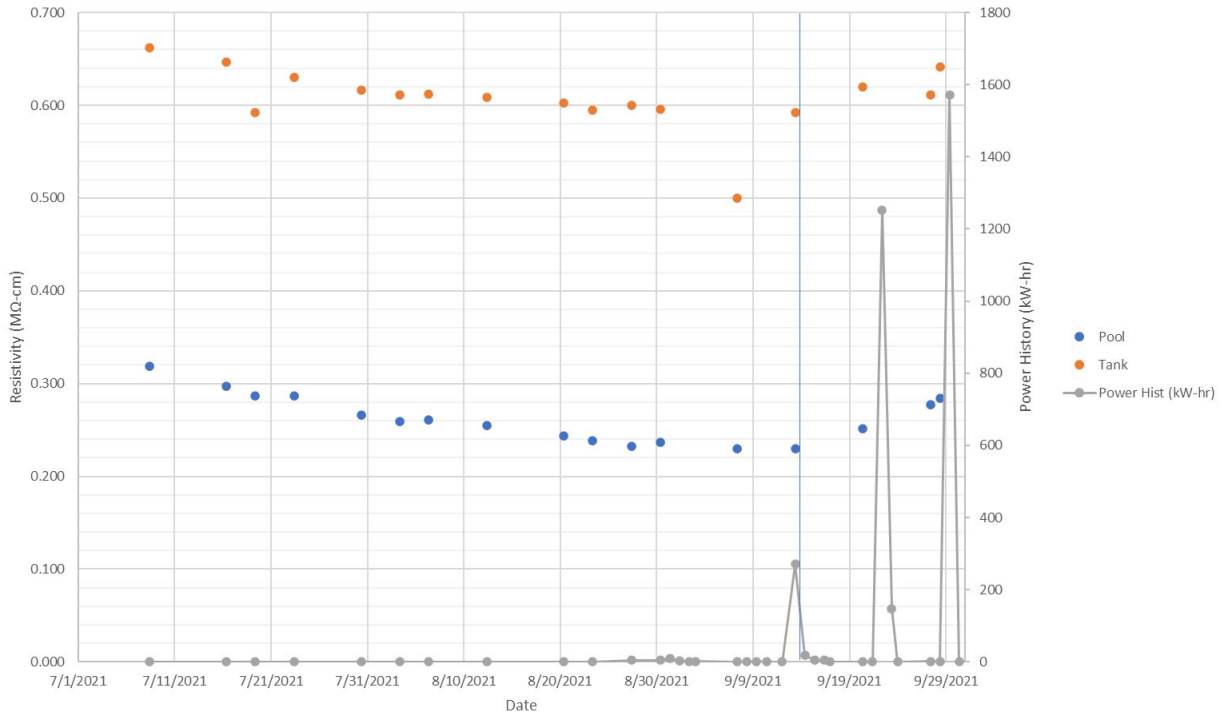

Figure 2 – MSTR Resistivity Data for Q3 2021 (Triggering Event in Blue)

On the morning of September 13, 2021, the Weekly Checklist was performed, with resistivity values of 0.230 MΩ-cm (pool) and 0.592 MΩ-cm (DI tank). September 13, 2021, also included the first extended high-power run since the spring academic semester, with power at 200 kW for a little over an hour (blue line on Figure 2). The corresponding decrease in pool resistivity was anticipated, although the magnitude to invoke the maintenance provision (value ≤0.2 MΩ-cm) was not. Note that dataset used for Figure 2 (the recorded resistivity values) does not show the drop below 0.2 MΩ-cm, and the console permanent log entry indicates the observation at 11:44 AM CDT.

Resins and supporting equipment were purchased to conduct the resin replacement. The replacement was scheduled to occur starting September 28, 2021, to allow for the supplies to arrive and DI tank activity to decay following a facility Argon-41 Concentration Evaluation (requires approximately 8 hours of full power operation). The replacement was estimated and scheduled based upon the previous installation documentation to take one day (which was thought to be conservative).

Difficulties were quickly encountered in the replacement process, with the tank lid removal taking several hours and repeated attempts. In the following days, staffing availability also

was substantially impacted due to an academic break on campus. The resins were evacuated and replaced, but tank lid reinstallation was not completed until October 3, 2021. Additional difficulties were encountered while reassembling the various tank flow, vent, and drain lines that required several iterations and testing to ensure acceptable sealing. These issues were not fully resolved until October 13, 2021.

The demineralizer system was restored to service the morning of October 13, 2021. Resistivity values were taken almost immediately (before the bulk pool resistivity could be affected), with readings of 0.354 MΩ-cm and 3.22 MΩ-cm for the pool and demineralizer tank, respectively. Readings were observed to continually increase. For the following week (October 18, 2021), resistivity values were 1.125 MΩ-cm and 11.85 MΩ-cm. This data is included in Figure 3.

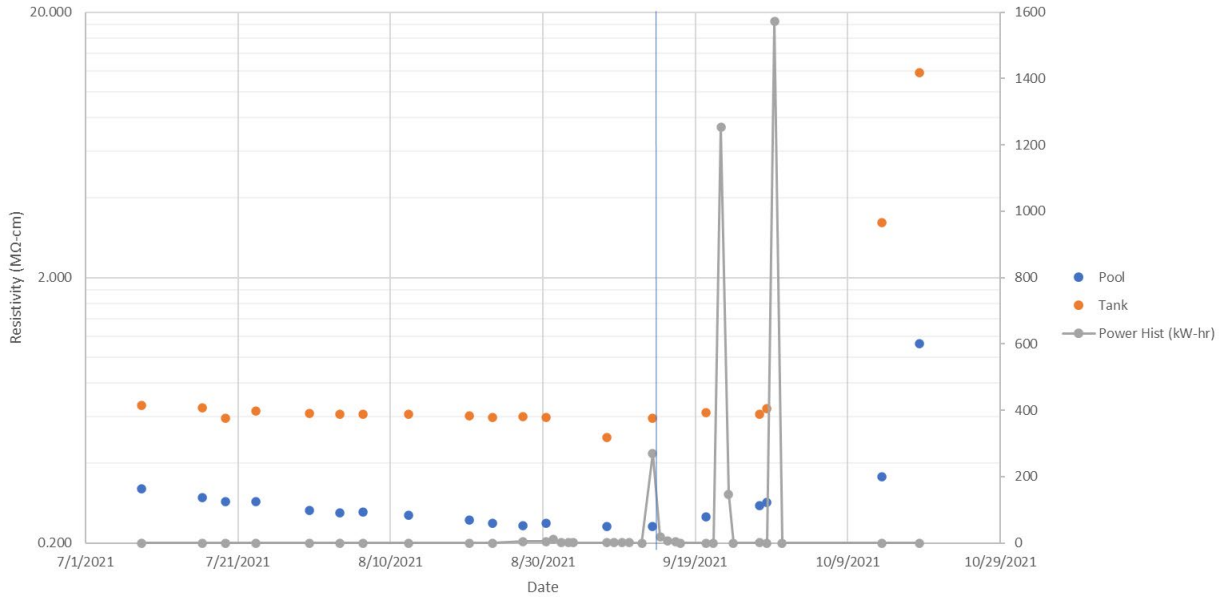

Figure 3 – MSTR Q3-Q4 2021 Resistivity Data Including Recovery (Log Scale)

Justification for Retraction

As seen in the historical data of Figure 1, MSTR pool resistivity tends to increase following high-power operations. While the sharp decline and timeline of recovery is not tracked in this data, staff observations estimate this time-period as one day. Conservatively, it is assumed that every high-power period of operations during the waiver period resulted in three days of decreased resistivity below the 0.2 MΩ-cm limit, followed by a recovery at or above the previous value.

The last recorded pool data point prior to the DI system being taken offline (the morning of September 28, 2021) was 0.284 MΩ-cm. Extended full power operations (1.6 MW-hr) were conducted during September 29, 2021. Based upon the assumed recovery period, pool resistivity should have recovered to at least 0.284 MΩ-cm by the evening of October 2, 2021 (72 hours post shutdown). When the DI system was brought back online (October 13, 2021), the pool resistivity was 0.354 MΩ-cm, further supporting the estimated October 2, 2021 value.

During the waiver period, the assertions would result in no more than nine non-contiguous days where resistivity was below 0.2 MΩ-cm. Additionally, this asserts that pool resistivity was above 0.2 MΩ-cm at the conclusion of the waiver period (October 4, 2021). In maintaining pool resistivity above the 0.2 MΩ-cm threshold at the conclusion of the waiver period, the MSTR would therefore not be in violation of TS 3.3(2).