



REACTOR FACILITY

July 31, 2008

US Nuclear Regulatory Commission
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This letter is to report an apparent violation of the Reed Research Reactor License and Technical Specifications that occurred on July 24, 2008. For approximately 70 minutes the reactor was operated above its licensed limit of 250 kW due to nuclear instruments being in error. The calculated power was 281 kW. Since the nuclear instruments were not indicating correctly, the 110% reactor scrams may not have tripped until a calculated power of 134%.

The Event

In January 2008 a fuel element in the reactor failed a routine inspection and was removed from service. Without this element in the core the reactor was unable to reach its normal operating power of 240 kW. The maximum attainable power was 180 kW to 220 kW, depending on the operating history and fission product inventory. The reactor operated in this condition from January 2008 until July 2008.

The facility installed a new fuel element on July 21, 2008. Due to the installation of the new element, calibrations of the control rods and the nuclear instruments were required. The calibration of the control rods proceeded without incident.

The Standard Operating Procedure (SOP-44) for nuclear instrument power calibration requires taking the reactor to an indicated power on the linear channel of 230 kW and operating for at least an hour while monitoring reactor pool temperature. Based on the rate of change of pool temperature the thermal power is calculated. When this calibration was performed on July 24, 2008, the calculated power was 281 kW, 22% higher than the indicated power and 12.5% higher than the licensed steady state power. Note that the data

from the thermal power calibration are unreliable until the reactor has been at power for approximately an hour, so it took that long to calculate the reactor power.

In order to check this unexpected result, the reactor power was lowered to an indicated power of 200 kW and another power calibration was performed immediately. The calculated power this time was 206 kW. Although this calibration was not official it was in good agreement with the expected value and called into question the earlier calibration at 230 kW indicated power. It was decided to shutdown the reactor since it was late and perform a check of the pool temperature instrumentation the next day. The Reed Reactor License requires that we call the Atomic Energy Commission regional office to notify them of the apparent violation, but the regional offices no longer oversee research reactors. We called our project manager at the NRC, Daniel Hughes, but since it was after 8 pm in Washington, D.C., we left a voice message. In retrospect, we should have called the NRC Operations Center at that time to report an apparent License violation. The NRC Operations Center was not called until 1130 on July 29, 2008.

The next day, July 25, 2008, the staff checked the accuracy of the pool temperature indication, and installed four additional temporary thermometers. It was thought that a faulty pool temperature indication might be the cause of the unexpected calculated power. However, when the pool temperature indication was checked over the range from 0°C to 100°C it performed properly and agreed well with the other, temporary, temperature indications.

An unofficial power calibration was performed on July 25 at an indicted power of 200 kW. The result was a calculated power of 237 kW. However, the procedure for power calibration requires that the reactor not have been operated at a power above 5 W for 48 hours prior to the calibration to allow fission product poisons to decay. Since this was the morning of July 25 and the reactor had been operated the previous afternoon, the calibration was not official and was not used to adjust the power indications. Similarly, the second calibration on July 24 (at 200 kW) did not meet the required initial conditions. We left another phone message with the project manager. Coincidentally, Patrick Isaac of

the NRC called us on a separate issue, and we told him what had occurred. The Reed Reactor Review Committee members were informed of the event via email.

On July 28, 2008, after the reactor had been shutdown for an adequate period of time to satisfy the procedural requirements, a power calibration was performed at 150 kW. The calculated power was 180 kW. The nuclear instruments were adjusted per procedure. The reactor has been shutdown since that power calibration.

The facility director discussed this event on the phone with the chair the Reactor Safety Committee on July 28 and with the chair of the Reactor Operations Committee on July 29, 2008.

The event was discussed with Daniel Hughes on July 28, 2008, and in a conference call with several members of the NRC, including Johnny Eads, Chief, Research and Test Reactors Branch B, on July 29, 2008.

It is worth noting that the facility's Technical Specifications allow operating the reactor at powers up to 287.5 kW to test the reactor high power scrams on the nuclear instruments. The reactor was below this allowed power, but since the test on July 24, 2008 was for a thermal power calibration of the nuclear instruments, not a test of their scrams, it is the opinion of the staff that this section of the Technical Specifications does not apply in this case. Although the reactor power was calculated to be within the limits allowed for testing the nuclear instruments, a different test was in progress and thus this constitutes an apparent violation of the Technical Specifications. Also, with such an error in the nuclear instruments, the Technical Specification required scrams on the Linear and Percent Power channels would not have tripped as required at 110% of 250 kW. A scram may not have occurred until 134%.

The Cause

The cause of the apparent Technical Specification violation was an unusually large disagreement between the indicated power and the calculated power due to the installation of the new fuel element. The indicated power on the Linear Channel was

230 kW. The Percent Power Channel indicated 220 kW. The Logarithmic Channel indicated approximately 250 kW. Note that the Logarithmic Channel is not as accurate as the other two channels at higher powers and generally reads high.

The difference between the indicated power on the Linear Channel (the normal power indication used to maintain power) and the calculated power was 22%. Historically, the difference between indicated and calculated power when performing a power calibration averages 2% to 3% and has not exceeded 6%, with the exception of the January 2008 calibration (after removing a fuel element) where the difference was between 10% and 19%. In retrospect, this difference on the January 2008 calibration should have warned us that installing an additional fuel element might cause a larger than normal difference.

Although the core configuration was only slightly different than it had been in the past, one additional element made a large change in the indicated reactor power. The Reed Reactor has a relatively small core excess at full power. The addition of a fuel element changed the full power rod height significantly, from 94% withdrawn down to 84% withdrawn. This change in the upper range of motion caused a very large change in the nuclear instruments since the detectors are physically located near the top outside of the core, well above the centerline. Thus a relatively small change in the rod height could cause a large change in the fraction of fission neutrons reaching the detector, i.e., detector efficiency. The data below, for a power of 185 kW (74% power), show the significant change in core excess and banked control rod height under the three core configurations.

	Core Excess	Rod Height
2007 (before removing a fuel element)	\$0.74	84%
Jan 15- Jul 21, 2008 (with a fuel element removed)	\$0.15	94%
July 28, 2008 (after adding the new fuel element)	\$0.63	85%

This large decrease in critical rod height after installing the new element shadowed the nuclear instruments from the actual core power, causing the erroneously low indication.

Corrective Actions

The reactor has not been operated since the apparent violation, except to perform power calibrations in order to investigate the event.

The joint Reactor Operations Committee and Reactor Safety Committee discussed the event by conference call and email on July 31. An official power calibration will be performed at 230 kW. If that shows no anomalies, normal operations will resume.

A procedure will be written on how and when to call the NRC. The Power Calibration Procedure (SOP-44) will be modified to require a preliminary power calibration at 150 kW following any change in the core configuration other than routine fuel inspections.

Please contact me with any questions or concerns.



Stephen G. Frantz
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