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U.S. Nuclear Regulatory Commission
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Special Report – Event Notification #53222
Operating License R-56, Docket 50-83
Technical Specification 6.7.2.a.3

This special report is submitted to describe the circumstances of Event Notification #53222. Initial event notifications to the NRC were made by telephone and email on February 20, 2018. Following a detailed review of the event, and additional discussion with NRC staff, some conclusions made in the initial notifications were modified for this report.

Summary of Occurrence

On February 16, 2018, during maintenance to calibrate the nuclear instruments, the reactor was operated at steady-state conditions with a calculated thermal power greater than indicated power as read on the Safety Channels. The difference between calculated thermal power and indicated power was greater than the difference between the installed Safety Channel trip settings and the High Reactor Power trip settings required by the Limiting Safety System Settings (LSSS). This is a reportable event in accordance with Section 6.7.2.a.3 of the Technical Specifications.

A sequence of events with additional details is provided in the attachment.

Conditions Prior to Occurrence

The reactor was operating at the time of the event. At time of discovery, the reactor was in a shutdown and secured condition.

LSSS Basis Statement

The Basis statement in Section 2.2 of the UFTR Technical Specifications states: “Due to the inherently safe core design and low EXCESS REACTIVITY, postulated reactivity insertion event analyses indicate no automatic control or safety functions are needed to prevent reaching the Safety Limit (Ref. SAR Section 13.2). Therefore, to allow for generation of a reasonable set of Technical Specifications, and provide defense-in-depth, the fundamental reactor parameters of power, temperature, and flow were conservatively chosen for incorporation as LSSSs. These very conservative settings ensure normal reactor operation remains within the assumptions of the thermal hydraulic analysis for normal operation (ONBR > 1) as described in SAR Section 4.6.”

Apparent Causes

UFTR staff failed to recognize that steady-state operation for calibration of the nuclear instruments, with indicated power less than thermal power by an amount greater than the margin between the installed High Reactor Power trip settings and the LSSS, created a reportable condition.

1. There was no procedural guidance addressing this condition.
2. There was no operator training addressing this condition.
3. The direction and magnitude of the mismatch between thermal power and indicated power was unknown until the event.
4. A decade old discussion related to this condition was not captured for evaluation and correction.
5. Reviews of nuclear instrument calibration procedure changes were inadequate in that they failed to catch and address this condition.
6. There is no thermal power indicator. This results in added operator burden particularly during operation for nuclear instrument calibration. During calibration the operator must be able to quickly and correctly calculate thermal power and compare the results to indicated power and procedural and license limitations.

Corrective Actions

1. Action Completed - Initial notification was made to UFTR Management, the Chair of the Nuclear Engineering Program, the Associate Dean of Research & Facilities, the Dean of the College of Engineering, the College of Engineering Safety Officer, and to members of the Reactor Safety Review Subcommittee.
2. Action Completed – The Senior Operators involved in this event held several face-to-face meetings to discuss the event, apparent causes, and the need to coordinate more closely prior to implementing changes that have an impact on Technical Specification compliance and/or reportability.
3. Action Completed – The facility reached out to several other research and training reactor facilities and the TRTR Chair to begin a discussion on the event and lessons learned.
4. Action Completed – An in-depth review of SOP-E.4 was performed.
5. Action Completed – Event Notification #53222 and this special report have been reviewed by the SRO's involved and added to required reading.

6. Action Completed – In August 2015, a revision was made to SOP-0.5, Quality Assurance Program, to add a Condition Reporting Form. The form was used for this event and the management expectation is that the form continue to be used to ensure future conditions adverse to quality are captured and evaluated as well. Had this form been in place ten years ago, we might have revised the applicable procedural guidance earlier and avoided this event.
7. Add a standing order to required reading documenting the management expectation that licensed operators and operator trainees: review future changes having impact on Technical Specification compliance and/or reportability; document any input or comments they may have; and, provide documented acceptance or disapproval of the proposed changes and resultant final product.
Due date - March 23, 2018.
8. Revise SOP-E.4 to temporarily lower the high-power trip settings prior to reactor startup for nuclear instrument calibration.
Due date - March 30, 2018.
9. Evaluate the feasibility of adding a thermal power indicator.
Due date - April 27, 2018.
10. Incorporate this event into the Technical Specification training materials.
Due date – On or before the next Technical Specification training.

This special report has been reviewed and approved by the Reactor Safety Review Subcommittee.

Please let us know if you need further information.

Sincerely,



Brian Shea
Reactor Manager

cc: Dean – College of Engineering
Reactor Safety Review Subcommittee
UFTR Facility Director
NRC Project Manager
NRC Inspector

Attachment

Details of Occurrence with Sequence of Events

Prior to reactor operation on February 16, 2018, the reactor was last operated near full-power on November 9, 2017. The reactor was operated twice that day and only briefly at near full-power. On the first operation that day, based on log readings, calculated thermal power was approximately 77kWth with an indicated power of 100% on both Safety Channels. On the second operation that day, based on log readings, calculated thermal power was approximately 88kWth with an indicated power of 100% on both Safety Channels.

Prior to November 9, 2017, the previous extended operation near full-power occurred on November 3, 2017. On this day, near full-power operation lasted approximately 3.5 hours. Based on log readings, calculated thermal power increased from approximately 93kWth to approximately 99kWth over the course of the 3.5 hours with an indicated power of 100% on both Safety Channels.

Between November 9, 2017 and the event date of February 16, 2018, maintenance was conducted on the nuclear instrumentation system including calibration of the nuclear instruments and temperature monitoring system.

On February 15, 2018, revision 5 of Maintenance Procedure SOP-E.4, UFTR Nuclear Instrumentation Calibration Check, was approved for use. This was a complete revision intended to significantly improve and clarify the procedure as well as the calibration records. This revision was written to be consistent with multiple recent maintenance actions that improved the calibration of the reactor power measuring channels. Additionally, this revision provided new guidance highlighting the need to carefully monitor primary temperatures and flow during performance of the calorimetric portion of this procedure to ensure the license power limit is never exceeded. No guidance previously existed, or was added, to address the potential for this event.

The facility currently has four licensed operators, all Senior Operators (SROs). Only two of the licenses are active. The two active SROs were the individuals responsible for originating the revision as well as for operation of the facility during the procedure use. One of the inactive SRO's is the longest tenured operator at the facility and the person who initially raised the concern which led to the event report determination. The other inactive SRO is a PhD student who, in order to focus on dissertation work, has little involvement in the day-to-day activities of the UFTR.

On February 16, 2018, the calorimetric and post-calorimetric portions of Surveillance Requirement (SR) 3.2.3.3 for LCO 3.2.3.1 were performed in accordance with the applicable UFTR procedures. The following sequence of events is based on the Operations Log record, phone records, email records, and personnel interviews and recollections. Note that all of the indicated and calculated values provided are approximations based on operator readings of the analog Safety Channel power meters, analog primary flow indicator, and digital temperature recorder indicators.

February 16, 2018

- 0740 SRs 3.2.2.1 and 3.2.3.1 were performed verifying the High Reactor Power trip function and setpoints. Safety Channel 1 was set to actuate at 110% and Safety Channel 2 was set to actuate at 108%.
- 0805 Reactor startup commenced. SRO#2 at the console. SRO#1 and the staff engineer also present in the control room.
- 0820 Reactor critical at 1-watt.
- 0825 Commenced power increase to near full-power.
- 0830 (Approximate time) Facility Director enters the control room.
- 0835 Power stabilized at indicated power of 94% as read on both Safety Channels with a calculated thermal power of 94kW. Safety Channels are tracking together and indicating the same power level.
- 0855 Power maintained at an indicated power of 94% but calculated thermal power has increased to 97kW due to primary and core material temperatures continuing to slowly increase and stabilize. This slow increase in temperatures, and lag between calculated thermal power and indicated power, after reaching near full-power are expected conditions.
- 0915 Indicated power of 94% with calculated thermal power of 97kW.
- 0935 Indicated power of 94% with calculated thermal power of 97kW.
- 0940 SRO#2 relieved by SRO#1.
- 0955 Indicated power of 94% with calculated thermal power of 97kW.
- 1015 Indicated power of 94% with calculated thermal power of 97kW.
- 1017 SRO#1 relieved by SRO#2. Indicated power lowered slightly to maintain a calculated thermal power of approximately 97kW.
- 1030 Indicated power of 93% with calculated thermal power of 97kW.
- 1050 Indicated power of 92% with calculated thermal power of 97kW. This slight lowering of indicated power with apparently unchanged thermal power is an expected condition until temperatures come back into equilibrium.
- 1110 Indicated power of 92% with calculated thermal power of 97kW.
- 1125 (Approximate time) SRO#3 enters the control room.
- 1130 Indicated power of 93% with calculated thermal power of 97kW.
- 1130 SRO#2 relieved by SRO#1. Turnover highlighted the hold at about 93% indicated power to maintain calculated thermal power of approximately 97kW. SRO#2, staff engineer, and Facility Director leave control room.
- 1135 (Approximate time) SRO#3 indicates he overheard the turnover between SRO#1 and SRO#2 and shares memories of a conversation he had approximately a decade earlier regarding operation with indicated power less than calculated thermal power. There was confusion about the concerns being expressed by SRO#3 however due in part to the timing and brevity of the communications.
- 1145 (Approximate time) SRO#2 returns.
- 1150 Indicated power of 93% with calculated thermal power of 97kW.
- 1200 (Approximate time) SRO#3 leaves.
- 1210 Indicated power of 93% with calculated thermal power of 97kW.
- 1230 Indicated power of 93% with calculated thermal power of 97kW.

- 1230 SRO#1 relieved by SRO#2 to begin performance of equilibrium calorimetric calculations for power adjustments of Safety Channels 1, 2, and the linear channel. Staff engineer returns.
- 1245 Safety Channels 1 and 2 are adjusted to approximately 99% with calculated thermal power of approximately 97kW. Indicated power is now calibrated to greater than calculated thermal power. Discovered that a fixed resistor in the linear channel adjustment circuit needs to be replaced to allow enough adjustment to complete the linear channel calibration.
- 1250 Indicated power of 99.5% with calculated thermal power of 98kW.
- 1310 Indicated power of 100% with calculated thermal power of 98kW.
- 1315 (Approximate time) SRO#1 and staff engineer leave.
- 1322 SRO#3 sends email to SRO#1, SRO#2, and the staff engineer with Condition Report write-up attached.
- 1325 Power lowered slightly to 97% indicated for operation in support of upcoming compensating voltage determination.
- 1330 Indicated power of 97% with calculated thermal power of 97kW.
- 1350 Indicated power of 97% with calculated thermal power of 97kW.
- 1410 Indicated power of 96% with calculated thermal power of 97kW (96.7kW). Even though calibrated to read approximately 2% greater than calculated thermal power, the Safety Channels are again indicating a power less than calculated thermal power though only slightly. This lag between indicated power and calculated thermal power is an expected condition until temperatures come back into equilibrium.
- 1415 (Approximate time) SRO#3 comes to control room to discuss his concerns with SRO#2. SRO#1 returns about this time as well. SRO#3 relayed memory of decade old discussions and concerns and possible method to mitigate those concerns. Methods discussed included adjustment of indicated power on Safety Channels 1 and 2 prior to operation, calibrations at reduced powers, and lowering of trip setpoints.
- 1430 Indicated power of 97% with calculated thermal power of 97kW.
- 1435 Reactor shutdown commenced.
- 1437 Reactor shutdown and secured. Commenced post-calorimetric and compensating voltage determination preparations.
- 1535 Linear channel compensating voltage set.
- 1550 Post-calorimetric calibration of Safety Channels 1 and 2 completed.

February 19, 2018

- 0900 (Approximate time) SRO#1 and #2 meet to discuss Condition Report and begin a detailed review and investigation to determine whether or not any violation occurred and whether or not there is a reportable event.
- 1400 (Approximate time) SRO#1 and #2 meet with the Facility Director to discuss the Condition Report. UFTR management makes the determination that UFTR will treat this as a violation and reportable event unless informed otherwise by the NRC. This determination starts the reportability clock in accordance with Section 6.7.2 of the Technical Specifications.
- 1545 (Approximate time) SRO#1, #2, and the Facility Director begin placing calls to other research reactor facility managers seeking opinions on this condition.

- 1600 (Approximate time) The manager at one of the research reactors (RTR#1) provides the opinion that there is no violation or reportable event. Reasoning is that the condition occurred and was corrected during a maintenance activity. Notes that finding indicated power less than calculated power during calibration is an expected occurrence particularly following maintenance on the nuclear instrumentation and that NRC understands this. Believes there is a long-standing NRC interpretation to this effect that he thinks is documented, perhaps in a SECY. RTR#1 recommends we contact NRC to confirm this before making a decision not to report the event. RTR#1 wants to hear how the conversation goes with NRC.
- 1642 SRO#2 emails rough draft of event notification report for UFTR management review.
- 1710 The manager at another research reactor facility (RTR#2) returns call to SRO#2. RTR#2 seems surprised that high flux trips might be considered inoperable or non-conservative if power channels are reading lower than thermal power during calibration. Indicates they would be found in violation if the interpretation doesn't allow for calibration at power as a maintenance activity. Also mentions that another RTR received a violation for exceeding licensed power during calibration years ago but not for operating with power channels reading lower than thermal power during that same calibration and that no one questioned the operability of the high-power trips during that event. Based on that licensed power violation, however, RTR#2 now does calibrations at significantly reduced power to avoid exceeding licensed power but doesn't make any trip setting adjustments prior to calibration. RTR#2 wants to hear how the conversation goes with NRC.

February 20, 2018

- 0830 (Approximate time) SRO#2 calls another research reactor manager (RTR#3) who answers and provides opinion that there is no violation or reportable event. Also notes that finding indicated power less than calculated power during calibration is just as likely as finding indicated power greater than calculated power during calibration. And, that the purpose of the surveillance is in fact to calibrate the channels and that NRC understands this. RTR#3 wants to hear how the conversation goes with NRC.
- 0950 (Approximate time) SROs#1 and #2 contact NRC PM to discuss the condition in some detail. PM provides personal opinion that it's probably "not a violation" but that it's dependent on how the relevant Technical Specifications are worded and that he would defer that decision to the oversight/inspection branch. Also suggests calling our prior inspector to inquire.
- 1010 PM calls back indicating he left messages for the acting licensing branch chief and oversight branch chief to discuss this.
- 1315 (Approximate time) SROs#1 and #2 call and reach the acting licensing branch chief and explain the scenario. He also provides opinion that it's probably "not a violation" but wants to check with oversight branch chief before committing to that position.
- 1430 (Approximate time) The manager at another research reactor facility (RTR#4) calls responding to SRO#2 email on this condition. Provides opinion that it would not be a violation since it occurred during a maintenance activity but that it might be reportable if it involves a non-conservative LSSS setting. RTR#4 also wants to hear how the conversation goes with NRC and the outcome.

- 1440 (Approximate time) Current NRC inspector calls. SRO#2 described scenario and prior precedents. Inspector indicates that a violation occurred and that it's reportable. Inspector states that high-power trip setpoints should have been lowered prior to the calorimetric operation. Inspector indicates that if event occurred as SRO#2 described then the event would be of little to no safety significance and UFTR would receive a verbal non-cited violation during exit of the upcoming inspection and that nothing would be written about it in the inspection report.
- 1529 SRO#3 emails a second Condition Report expressing concerns about how temperature uncertainty was used in the calculation section of the calibration procedure. This second condition is not an operability or reportability issue.
- 1619 SRO#2 emails revised draft event report for UFTR management review.
- 1645 SRO#2 calls and emails the NRC HOO/HOC making the official event notification to the NRC (EN#53222).

February 23, 2018

- 1345 (Approximate time) SRO#2 called another research reactor manager (RTR#5) who indicated this scenario could result in a violation and reportable event had it occurred at their facility. This facility operates using thermal power indication and has procedural guidance designed to avoid having indicated power less than thermal power and to avoid a non-conservative high-power trip setting during routine power ascension and subsequent steady-state conditions.

February 27, 2018

- 1330 (Approximate time) SRO#2 called RTR#5 again to inquire further on how they handle power mismatches during power reductions and following nuclear instrument maintenance. RTR#5 indicates thermal power lags indicated neutron power there as well but that their expectation is that thermal power be less than indicated neutron power once equilibrium conditions are reached again. RTR#5 indicates they avoid performing outage maintenance on more than one required nuclear instrument channel. RTR#5 indicates that if following maintenance one required power channel is found to be indicating lower than thermal power, or the other required power channels, they will pause power ascension after reaching the point-of-adding-heat and perform an initial power channel alignment. He acknowledges that, dependent on the magnitude of the initial power mismatch, this could be interpreted as an operability issue and/or reportable event and that he's relying on NRC consideration of the fact the mismatch was corrected at relatively low power.
- 1615 (Approximate time) SRO#1 and SRO#2 have conference call with NRC PM and licensing branch chiefs (current and acting) to request event report withdrawal with facility commitments to prevent reoccurrence. NRC indicates they want to review the special report details and defer discussion of event report withdrawal. NRC indicates event may not be a Technical Specification violation but that it is considered reportable. NRC suggests a LCO change to lower high-power trip setpoints. SRO#2 indicates the calibration procedure will be revised to temporarily reduce high-power trip setpoints prior to operation for nuclear instrument calibration.

References

1. Operations Logs.
2. Administrative Control Procedure SOP-0.5, Quality Assurance Program.
3. Maintenance Procedure SOP-E.4, UFTR Nuclear Instrumentation Calibration Check.
4. Routine Operating Procedure SOP-A.1, Pre-operational Checks.
5. Routine Operating Procedure SOP-A.2, Reactor Startup.
6. Routine Operating Procedure SOP-A.3, Operation at Power.
7. Routine Operating Procedure SOP-A.4, Normal Reactor Shutdown.
8. Facility Operating License No. R-56 dated March 31, 2017.
9. Facility Technical Specifications dated March 31, 2017.
10. Facility SAR dated March 6, 2017.