Nuclear Reactor Laboratory
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RE: Annual Report for License R-52, Docket 50-113

This is our Annual Report covering the period July 1, 2005, through June 30, 2006, for the activities of the TRIGA Mark I Reactor at the University of Arizona, Tucson, Arizona. This report is submitted in compliance with Section 6.7e of the Facility Technical Specifications and Paragraph 50.59(b) of Title 10, Code of Federal Regulations.

1. During the reporting period, the reactor was operated for research and education. The reactor was used for graduate thesis research. The reactor was also used for neutron activation analysis by the University's Planetary Science Department, and for dosimetry on irradiated soil samples.

   There were no reactor upgrades or modifications during the reporting period.

   Power channel calibration by the calorimetric method was performed during the reporting period. We measured the total worth of the Regulating, Shim, and Transient rods to be $3.99, $3.17, and $2.49, respectively. The largest change in worth was 2¼ % of total worth on the Regulating rod.

   We measured maximum reactivity insertion rates of $0.17/sec, $0.11/sec, and $0.17/sec for the Regulating, Shim, and Transient rods, respectively. All three insertion rates were less than the $0.20/sec maximum rate allowed by the facility technical specifications.

   We twice inspected the Transient rod drive assembly during the reporting period. Both piston seals were found to be in satisfactory condition and no wear or rust accumulation was present in the air cylinder.

   Rod drop times from full out to full insertion were measured to be 0.36, 0.38, and 0.96 seconds for the Regulating, Shim, and Transient rods, respectively. The Regulating rod falls 5.3% faster; the Transient 8.6% slower. All three drop times were less than the time required by the facility technical specifications. We visually inspected the Regulating, Shim, and Transient rods during the reporting period. All three control rods passed visual inspection. We fully extracted the Transient rod and wiped accumulated "slime" off during the inspection. We believe removing this slime caused the Transient rod's slower drop time.

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Per existing procedures we calibrated the area radiation monitors, the pool activity monitor, and the pool conductivity meter during the reporting period.

2. The reactor was critical for a total of 51½ hours, producing 1474.2 kW-hours (0.061 MW-days) of thermal energy. Our cumulative energy output since the facility was commissioned is 9.924 MW-days.

   We performed nine pulses or reactivity insertions greater than $1.00 during this reporting period. A cumulative 35 pulses have been performed since the previous fuel measurement in May 2002, and we have performed a total of 2,244 pulses.

   The reactor was in operation 57 days during the reporting period, with 73.8 hours of operating time, as recorded by the console clock.

3. No inadvertent reactor SCRAMs or emergency shutdowns occurred during the reporting period.

   There were two items of interest during this reporting period.

   A. During the fall 2005 the background radiation collected and detected by our continuous air monitor (CAM) showed a steady increase in the reactor room. Prior to the fall the CAM rarely read higher than 250 counts per minute. When it did we could attribute the elevated level to construction at the Student Union next door or a temperature inversion in the Tucson atmosphere. In the fall of 2005, with the Student Union remodeling completed, the CAM radioactivity counts climbed to continuously read above 250 cpm, with periods exceeding 2000 cpm. Our set point is 5000 cpm, and we approached half that value regularly. The CAM showed a daily cycle of climbing radioactivity during the night and falling levels throughout the day. We asked RCO to evaluate our reactor pool water and conduct radiation surveys throughout the Engineering Building. The reactor pool water was fine, no indication of a broken fuel element. RCO conducted surveys over the Christmas holidays, December 2005 to January 2006, and again in late January 2006. RCO found elevated radon levels in two of the facility's rooms. The spikes were occurring at night when the Engineering Building was closed. We believe the air pressure inside the Engineering Building is below the ambient pressure outside. When the building was unoccupied and closed at night, the lower interior pressure caused radon to migrate from the soil and brick walls into our Reactor Room. The crawl space beneath the Reactor Room floor is dirt. The University's Facilities Management Department has since replaced the air filters in our building's air handlers, and this problem has greatly diminished. Our highest levels now occasionally reach 600 cpm.

B. The afternoon of June 8, 2006, during preliminary startup checks, the reactor room exhaust fan functioned erratically. With the switch 'on,' the blower would start and stop randomly. No reactor operations were conducted, and Nuclear Reactor Laboratory staff commenced troubleshooting. We found confusing electric voltages and contacted the University's Facilities Management (FM) Department. FM immediately dispatched an electrician who discovered that our facility "had lost a phase." One of the two phases of electric power supplying our facility lab was gone. Following the building's wiring got us to a charred, burned wire in Room 263 in the Engineering Building, a space belonging to the Systems and Industrial Engineering Department and well away from the reactor facility. There had been a minor, self-extinguished fire. The following day electricians replaced the wire. The facility was returned to operation, and we have encountered no subsequent electrical problems.

4. Major maintenance included:

   A. Replacement of the HV2 power supply with a power supply identical in characteristics except for a digital meter.

   B. Replacement of the 15 VDC power supply, PS 204.

   Minor maintenance items included servicing the CAM air pump, adding pool water lost by evaporation, replacing burned out light bulbs in the reactor pool, replacing burned out annunciator bulbs in the reactor control console, changing batteries in the low water level detector circuit and area monitors, and making periodic adjustments to the reactor control console circuitry.

5. The Reactor Committee met four times during the reporting period: September 1 and December 8 in 2005, and March 9 and May 8 in 2006.

   At its meetings and in individual reviews by Committee members, the Committee reviewed operations and operational records of the facility as specified by the Committee charter. This included audit of preliminary check sheets, pulsing check sheets, approach to critical and termination check sheets, operations and maintenance log books, monthly and annual check sheets, irradiation records, and experiments performed with the reactor.

   On March 9, 2006, the Reactor Committee reviewed one 10CFR50.59 safety evaluation, concerning a new procedure (UARR 168, attached) for use of a new timer, the Rabbit Pulse Timer, for our pneumatic transfer system. This involved no change in the physical operation of the pneumatic system, only its timing. The Reactor Committee considered the questions in UARR 165 (attached)–which cover the requirements of 10CFR50.59(c)(2) and our facility's Technical Specifications–and answered all of them in the negative. On this basis, a change in the timing system does not affect the consequences or likelihood of an accident or create the possibility of a new kind of accident.

The reactor committee approved our administrative procedures granting sensitive area access.

6. We discharged no liquid or solid waste from the facility during the reporting period. We transferred four bags of dry, solid waste with only background radioactivity to the RCO for final disposal.

   Measurements of the Argon-41 concentration in the reactor pool water have demonstrated that the maximum rate of release of Argon-41 from reactor pool water is less than 0.74 μCi per kilowatt-hr of reactor operation. The pneumatic transfer system produces approximately 0.05 μCi of Argon-41 per kW-min of reactor operation, some of which is released when the system is operated. Presented below are the calculations of the maximum semiannual releases of Argon-41 from the reactor pool surface, the pneumatic transfer system, and the totals.

Period	Argon-41 (μCi) from Pool Surface	Argon-41 (μCi) from Pneumatic Transfer System	Argon-41 (μCi) Total
July to December, 2005	883	1820	2703
January to June, 2006	209	0	209
TOTAL	1092	1820	2912

   The calculations for Argon-41 release from the pneumatic transfer system do not include decay of the isotope prior to release and, therefore, over-estimates our Argon-41 release. The maximum total estimated Argon-41 release from the facility during the reporting period is 2.9 milliCuries. There were no other gaseous effluents from the facility during the reporting period.

7. Eight (8) persons were issued film badges on a monthly basis for all or part of the reporting period in the Nuclear Reactor Laboratory. The persons receiving badges included all reactor operators, faculty and staff members using the reactor laboratory, and researchers. The most an individual received was a 30-millirem exposure.

   Sixty (60) non-badged persons were admitted to the Reactor Laboratory in tours, inspections, maintenance, or other official business during the twelve-month reporting period. All were issued self-reading pocket dosimeters. Pocket dosimeters issued to visitors indicated that no exposure was received.

   Radiation surveys of the reactor room, control room, and experiment set-up room were conducted monthly during the reporting period by members of the University of Arizona Radiation Control Office (RCO) using direct measurement and wipe tests. The results show little detectable activity except where expected (i.e., irradiated samples in storage areas and internal wall surfaces of the irradiation facilities).

Members of the reactor laboratory staff performed other radiation surveys when necessary. No radiation exposure, which can be attributed to reactor operations, has been detected outside the reactor laboratory.

8. Three environmental TLD monitors on the roof of the Engineering Building and ten environmental TLD monitor sites on the roofs of 10 buildings provide a radio-dosimetry perimeter around the Engineering Building where the UARR is located. Two control TLD monitors are maintained in the Radiation Control Office to give a campus background. For calendar year 2005—the period for which RCO data exists—the dose rate, after subtraction of the average background reading for 11 of 13 TLDs were 0 mR/yr. One TLD on the Arizona Health Sciences Center and another TLD atop the Art Building read 9.4 mR/yr and 28.3 mR/yr, respectively. These higher readings are attributed to building materials and remain consistent with radiation doses found in prior years at these locations. There is no evidence that radiation exposures in the vicinity of the reactor are higher than normal. Eight TLD monitors were placed at the periphery of the restricted area, and two TLD monitors were placed in an office area far removed from the restricted area to provide a baseline reference for the Engineering Building background. The exposures recorded by TLDs on the periphery of the NRL ranged from 5 mR/yr to 81 mR/yr. The areas where monitors exceeded 100 mR/yr were surveyed using a calibrated ion chamber quarterly by the Radiation Control Office with the reactor operating at 100 kW. No radiation fields were detected that exceeded background levels (0.01 mR/hr).

Two background monitors are placed in Room 111 of the Engineering Building. The minimum detectable dose for these monitors is 1.0 mRem/qtr for photon radiation. Area monitors are placed in and around the Reactor Room to monitor the beta dose.

The area in the UARR Environmental TLD monitors at three locations on the roof of the Engineering Building, where the monitor readings exceeded 100 mrem/yr (without background subtraction) was surveyed with a calibrated ion chamber, with the UARR operating at 100 kW. No radiation fields were detected that exceeded background levels (0.01 mR/hr.). Additionally these areas are not continuously occupied, and instrument dose rates demonstrate exposure rates to be <0.01 mR/hr.

To meet the requirements of 10CFR20.1302, the sum of internal and external radiation dose to the public must not exceed 100 millirem/year or 2.0 mR/hr. With the reactor operating at maximum power (100kW), no instrument reading exceeded 0.01 mR/hr. To estimate the radiation dose from external and internal radiation sources, the highest environmental monitor reading is summed with the ^{41}Ar estimated dose and multiplied by an occupancy factor (0.25). The dose in R/124A, middle of the North wall, adjacent to the secured electrical transformer enclosure (145 mR/year) and Comply Code estimated dose (0.3 mR/year) are summed and multiplied by the occupancy factor (0.25), to estimate dose to the public of 36.3 mRem/year. This meets the requirements as stated above.

In writing this report, I have tried to be both complete and as brief as is reasonable, and still satisfy the requirements of 10CFR50.59, our Technical Specifications, and the needs of the Commission. If other or more detailed information is needed, please contact me at your convenience.

Sincerely,

John G. Williams, Director
Nuclear Reactor Laboratory

Attachments
UARR 168
UARR 165 rev 1

cc:
Events Assessment, Generic Communications and Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Mr. Marvin Mendonca
Project Manager USNRC

Dr. Leslie Tolbert, Vice President for Research
University of Arizona

Dr. Michael Cusanovich, Director Arizona Research Laboratories
University of Arizona

UARR 168

PROCEDURE FOR USE OF THE RABBIT PULSE TIMER

The Rabbit Pulse Timer is used to control the operation of the pneumatic transfer system (the Rabbit) when a sample is irradiated in pulse mode operation and then transferred immediately from the reactor core after a pulse.

1. Before installation, the Rabbit Pulse Timer will be connected to the reactor and rabbit system and tested using the "Normal Operation" and the "Contingency Operation" sequences with a empty capsule. The Normal Operation sequence is the sequence expected to be performed for the irradiation of each sample, and the Contingency Operation sequence includes other steps that may be needed in some eventualities.
2. Each day when the system is to be used, after the pulse checklist has been completed, the "Normal Operation" and the "Contingency Operation" sequences will be tested with an empty capsule (reactor non-critical).
3. The Normal operation sequence is as follows:
   - 3.1. Manually load capsule in rabbit loading tube
   - 3.2. Turn on the vacuum blower using the manual toggle switch (Blower On)
   - 3.3. Transfer sample into core using the momentary toggle switch (Sample In)
   - 3.4. Operator initiates a reactor pulse (Transient Rod Fire button is pressed)
   - 3.5. The timer system outputs a trigger pulse to start the experiment data collection system, and then operates the blower to transfer the capsule out of core after a brief delay
   - 3.6. Turn off the vacuum blower using the manual toggle switch.
4. The Contingency operation sequence is as follows:
   - 4.1. Manually load capsule in rabbit loading tube
   - 4.2. Turn on the vacuum blower using the manual toggle switch (Blower On)
   - 4.3. Transfer sample into core using the momentary toggle switch (Sample In)
   - 4.4. Transfer capsule out of core without reactor pulse using the momentary toggle switch (Sample Out)
   - 4.5. Transfer sample back to core, after pulse or after manual transfer out, using the momentary toggle switch (Sample In)
   - 4.6. Transfer capsule out of core without reactor pulse using the momentary toggle switch (Sample Out).
5. Prior to installation of a sample, complete the Irradiation Request and Material Transfer Form (yellow), marking the desired operation as "Pulse mode".
   - 5.1. For duration of the operation use "1 second"
   - 5.2. For power (kW) the energy of the pulse must be predicted in MJ and multiplied by 1000.
   - 5.3. Prediction of the activity produced and the dose rate is done using these values, and based on the steady state values of neutron fluence rate per kW.
6. After a pulse and transfer of a sample out of the core, the sample must be returned to the core for decay if any area monitor alarms, or if the dose rate at one foot is found to exceed 100mR/hr.

The Reactor Committee reviewed and approved this procedure on 3/9/2006

J. G. Williams
Director, Nuclear Reactor Laboratory

A. T. Bahill
Chairman, Reactor Committee

PROCEDURE FOR REVIEW OF CHANGES, TESTS, AND EXPERIMENTS FOR THE UNIVERSITY OF ARIZONA RESEARCH REACTOR

All facility changes, procedural changes, tests, and experiments must meet the conditions set forth in 10 CFR 50.59 (C)(2) in order to make these changes without prior approval of the Nuclear Regulatory Commission. In addition, these changes must be tested in accordance with the specification to which the systems were originally designed and fabricated or new specifications must be approved by the Reactor Committee as stated in T.S. 4.5 (b).

The following checklist provides a means to document the facility's compliance with 10 CFR 50.59 (C)(2) and T.S 4.5 (b) for all changes.

Proposed Change or Test:____

Yes No

1. Can the change result in more than a minimal increase in frequency of the occurrence of an accident? or

2. Can the change result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component important to safety? or

3. Can the change result in more than a minimal increase in the consequences of a previously evaluated accident? or

4. Can the change result in more than a minimal increase in the consequences of a malfunction of a structure, system, or component important to safety as previously evaluated? or

5. Can the change create the possibility for an accident type not previously evaluated in the Final Safety Analysis Report? or

6. Can the change create the possibility for a malfunction of a structure, system, or component important to safety with a different result than previously evaluated? or

7. Can the change result in a design basis limit for a fission product barrier being exceeded? or

8. Can the change result in a departure from a method of evaluation used in establishing design bases or in safety analysis? and

9. Can the change be made and tested in accordance with the specifications to which the systems were originally designed and fabricated?

The proposed change or test may be made without a prior approval of the Nuclear Regulatory Commission.

The proposed change or test may not be made without a prior approval of the Nuclear Regulatory Commission.

Reactor Committee Chairman

Reviewed and approved by the Reactor Committee on March 7, 2001, Revised 8/31/2004.

J. G. Williams, Director
Nuclear Reactor Laboratory

8-31-04
A. T. Bahill, Chairman
Reactor Committee