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License R-74
Docket 50-156

July 29, 2016

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Dear Sir:

Enclosed is a copy of the 2015-2016 Annual Report for the University of Wisconsin Nuclear Reactor Laboratory as required by Technical Specification 6.7.1(1).

Sincerely,

Robert J. Agasie
Reactor Director

Enc. (Annual Report)

cc: Compliance Inspector, Craig Bassett
Facility Project Manager, Spyros Traiforos
Reactor Safety Committee, RSC 1278

A020
NRR

THE UNIVERSITY OF WISCONSIN
NUCLEAR REACTOR LABORATORY

FISCAL YEAR 2015-2016 ANNUAL OPERATING REPORT

Prepared to meet reporting requirements of:

U. S. Nuclear Regulatory Commission
License R-74
Docket 50-156
Technical Specification 6.7.1(1)

Prepared by:

Robert J. Agasie
Department of Engineering Physics

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A. SUMMARY OF OPERATIONS

1. INSTRUCTIONAL USE

Nuclear Engineering (NE) 231, "Survey of Nuclear Engineering" was offered in the spring semester with an enrollment of 12 students. The course is designed for freshmen students interested in nuclear engineering and consists of three lecture modules surveying fission, fusion and radiation science technologies. The fission module concludes with a reactor tour.

Four sections of NE 427 were offered during the academic calendar year with a total enrollment of 46 students. Several NE 427 experiments use materials that are activated in the reactor. One experiment entitled "Radiation Survey" requires that students make measurements of radiation levels in and around the reactor laboratory.

Three sections of NE 428 were offered during the academic calendar year with a total enrollment of 26 students. Three experiments in NE 428 require exclusive use of the reactor. These experiments ("Critical Experiment", "Control Element Calibration", and "Pulsing") required a total of 36 hours of exclusive reactor use. Other NE 428 laboratory sessions use material that has been irradiated in the reactor ("Fast Neutron Flux Measurements by Threshold Foil Techniques" and "Resonance Absorption").

Individual class sections for Nuclear Engineering 405, "Nuclear Reactor Theory" were held at the Reactor Laboratory, with 6 students participating.

The Reactor Laboratory's continued commitment to its educational outreach program and community service attracts large numbers of community organizations who visit the reactor. A listing of individual schools and educational programs that have visited or received services is provided below in section A.2 of this report.

2. OUTREACH AND COMMUNITY SERVICE

Participating Institution	Number of Participants

Abundant Life Christian High School 17

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.

American Nuclear Society 22
UW-Madison Student Branch

Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of nuclear science and engineering research as part of the 2016 American Nuclear Society Student Conference hosted at the University of Wisconsin.

Beloit College 0

Analyzed swipe tests to leak check radioactive sources and performed detector calibrations.

Boy Scouts of America 324

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. Program included hands on demonstrations of radiation detection and shielding. Program co-sponsored by the UW student branch of the American Nuclear Society in support of the Scouts Atomic Energy Merit Badge program.

College Menominee Nation 6

Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of nuclear science and engineering research as well as career opportunities in nuclear science and engineering.

Cooperative Educational Service Agency 20

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. The Cooperative Educational Service Agency (CESA) is designed to serve educational needs in all areas of Wisconsin by serving as link between school districts and the state. CESA provides leadership, coordination, and education services to school districts, University of Wisconsin System institutions, and technical colleges.

Participating Institution	Number of Participants

Engineering Summer Program (ESP) 32

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. The ESP Program is targeted to high school students from groups traditionally under-represented in the STEM (science, technology, engineering, mathematics) field.

Madison Academic Staff Association Tour 23

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. The Madison Academic Staff Association (MASA) is a professional organization that serves the community of academic staff at the University of Wisconsin. MASA highlights the important contributions made by academic staff on campus.

Mount Horeb School 17

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.

PLATO 17

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. PLATO (Participatory Learning and Teaching Organization) is a self-directed, volunteer-led, nonprofit organization serving more than 900 lifelong learners living in and around Dane County. Most members are approaching or actively enjoying retirement. All share a passion for learning and a desire to stay engaged with the world and with others who share their interests.

UW College of Engineering 15
Graduate Engineering Research Scholars

Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of nuclear science and engineering research as well as career opportunities in nuclear science and engineering. The Graduate Engineering Research Scholars (GERS) is a unique fellowship program designed to offer underrepresented students a support network of peers and professional development opportunities.

Participating Institution	Number of Participants

UW Engineering Physics Department
Graduate Student Recruitment Program 28

Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of graduate research recruitment program.

UW PEOPLE 41

Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. PEOPLE (Pre-College Enrichment Opportunity Program for Learning Excellence) is a pre-college pipeline for students of color and low-income students. The program prepares the students to apply, be successfully admitted and enroll at the University of Wisconsin-Madison. It is the UW's most successful venture in creating such opportunities and thereby improving campus diversity.

UW Police Department 43

Awareness training including a discussion on reactor emergency preparedness and response procedures.

UW-Whitewater
Department of Physics 0

Analyzed swipe tests to leak check radioactive sources and performed detector calibrations.

OUTREACH AND COMMUNITY SERVICE USER SUMMARY:

Organizations: 15

Participants: 605

3. SAMPLE IRRADIATIONS AND NEUTRON ACTIVATION ANALYSIS SERVICES

There were 236 individual samples irradiated during the year. Samples accumulated 92.3 irradiation space hours and 134.8 sample hours. Many samples were irradiated and then counted at the Reactor Laboratory as part of our neutron activation analysis program. In the listing below the notation (NAA) indicates that the samples were processed by our neutron activation analysis program.

Department of Electrical & Computer Engineering, UW-Madison
1 sample, 0.1 sample hours
Irradiation of hafnium dioxide semi-conductors to induce damage that will change the electrical properties of the material.

Department of Engineering Physics, UW-Madison
3 samples, 0.8 sample hours
Irradiation of fiber optic and diamond diode temperature sensors as part of the Advanced Instrumentation for Transient Reactor Testing program at the UW-Madison in support of the DOE TREAT transient reactor restart initiative.

Department of Engineering Physics, UW-Madison
Nuclear Instrumentation Laboratory
140 samples, 82.8 sample hours
Irradiation of foil sources for radiation detector experiments, including absolute counting for neutron flux measurements and activation of samples for neutron activation analysis experiment.

Department of Engineering Physics, UW-Madison
NE 428
24 samples, 25.9 sample hours
Irradiation of foils for resonance absorption measurements and fast neutron flux measurements.

Department of Engineering Physics, UW-Madison
UW Nuclear Reactor Laboratory
6 samples, 14.0 sample hours
Production of calibration sources for required reactor measurements and development of methods for instrumental neutron activation analysis.

Oak Ridge National Laboratory **(NAA)**

14 samples, 6.2 sample hours

NAA to identify materials on a cotton swipe inside a plastic bag without opening the bag in support of policies pertaining to the Nuclear Non-Proliferation Treaty.

TRC Solutions **(NAA)**

48 samples, 5.0 sample hours

Industrial user interested in metallic contamination in urban soils impacted with lead.

4. OTHER MAJOR EDUCATIONAL AND RESEARCH USE

The University of Wisconsin Nuclear Reactor (UWNR) has partnered with the Knolls Atomic Power Laboratory (KAPL) to measure energy deposition in various materials important in the design of reactor systems to validate their MC21 Monte Carlo (MC) modeling code. This work used a differential calorimeter designed for the UWNR to measure the total heating rate in the various materials. From July 2015 through May 2016 the reactor dedicated 87.69 MW-hr to the experiment.

5. CHANGES IN PERSONNEL, FACILITY AND PROCEDURES

Any changes reportable under 10 CFR 50.59 are indicated in section E of this report.

Other changes to the facility included the replacement of the GA NLI-1000 period amplifier with a UWNR designed and built period amplifier.

There were no personnel changes during the year.

6. RESULTS OF SURVEILLANCE TESTS AND INSPECTIONS

The program of inspection and testing of reactor components continues, satisfactorily meeting procedural acceptance criteria. Inspection of underwater components during the annual maintenance showed no deterioration or abnormal wear.

The pool leak surveillance program continues to monitor the pool evaporation rate, the pool make-up volume, and pool water radioactivity. The pool leak surveillance program indicated that no water effluent has been released to the environment.

B. OPERATING STATISTICS AND FUEL EXPOSURE

Operating Period	Critical Hours	MW-Hrs	Runs	Pulses
Fiscal Year 2015-2016	231.78	127.79	184	38
Cumulative TRIGA 30/20 LEU	2,247.01	1,417.52	1033	265

Core K21-R6 was operated throughout the year. The excess reactivity of this core was determined to be 4.110%ρ.

C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There were four automatic SCRAMS or manual emergency shutdowns during the year. Each is described below in chronological sequence.

August 12, 2015; SCRAM from picoammeter number 2. While performing a normal reactor startup, a reactor operator failed to uprange the picoammeter to the next higher range. As a result, a reactor SCRAM from a neutron high flux trip at 125% occurred.

October 21, 2015; SCRAM from picoammeter number 2. While performing a normal reactor startup, a reactor operator trainee inadvertently upranged two ranges on the picoammeter and rapidly downranged one range to correct the mistake. The subsequent electronic noise of the rapid range switch adjustments resulted in a SCRAM from a neutron high flux trip.

February 24, 2016; SCRAM from picoammeter number 2. While performing a normal reactor startup, a reactor operator trainee failed to uprange the picoammeter to the next higher range. As a result, a reactor SCRAM from a neutron high flux trip at 125% occurred.

March 16, 2016; SCRAM from picoammeter number 2. While performing square wave operations, a reactor operator trainee inappropriately added additional reactivity before the fuel temperature coefficient of reactivity became dominant. As a result, a reactor SCRAM from a neutron high flux trip at 125% occurred.

D. MAINTENANCE

The Preventive Maintenance Program continues to maintain equipment and systems in good condition. Routine regeneration of demineralizer resins occurred on February 1, 2016.

Corrective maintenance performed as a follow up action necessary for reactor restart following an automatic SCRAM is covered in section C of this report. Additional corrective maintenance was performed on the following installed systems, structures and components (SSC) as described in the SAR:

During the semi-annual calibration of the SERVO/automatic control system the deadband/driver amplifier was found to be experiencing oscillation. It was found that the period limit input was the cause. Replacing the series diode on the output from the LogN-Period signal resolved the issue.

On September 3, 2015 the reactor control panel annunciator had failed as a result of the failure of an internal twin point sequence card. The card was replaced with a spare

and the annunciator was returned to service. Subsequently on April 18, 2016 another twin point sequence card failed. Upon visual inspection, the card showed the electrolyte from the card's only electrolytic 50V 100µf capacitor had leaked. New 50V 100µf capacitors were ordered and installed in all of the twin point sequence cards as it was felt that it was just a matter of time before all of the 25 year old capacitors failed. The annunciator was returned to service.

On September 3, 2015 during the pre-startup checklist an operator observed control blade number 2 position indication read 10.63 inches while the IN limit was illuminated. Inspection at the drive revealed the chain slipped off the gear. With the drive at the full IN position, the position indication gear was adjusted to read 0.00 and the chain was replaced. The operator continue with the pre-startup checklist with no further issues. Subsequently on November 12, 2015 during a normal reactor shutdown the operator observed control blade number 2 position indication read 11.00 inches while the IN limit was illuminated. Inspection at the drive revealed the set screw locking the gear to the indicator shaft had backed off and the gear was allowed to turn free relative to the shaft. With the drive at the full IN position, the position indication gear was adjusted to read 0.00 and the set screw was firmly tightened to lock the gear to the indicator's shaft.

During the November 23, 2015 weekly checks of the Area Radiation Monitoring (ARM) system, Beamport #1 ARM went into continuous discharge. The GM tube was replaced and the ARM recalibrated per procedure.

On March 29, 2016 with the reactor shutdown while demonstrating use of the pneumatic tube a returning rabbit jammed in the send/receive terminal drawer. The drawer could not open to remove the rabbit. The pneumatic tube was declared out of service until repairs could be made. Repairs required disassembling the send/receive terminal to remove the rabbit. It was determined the end cap of the rabbit came off thereby raising the height of the rabbit sufficiently enough that the drawer would jam. The rabbit was retired. The pneumatic tube send/receive terminal drawer was reassembled and the system put back in service.

E. CHANGES IN THE FACILITY OR PROCEDURES REPORTABLE UNDER 10 CFR 50.59

There were no changes to the facility reportable pursuant to 10 CFR 50.59 completed during the year.

F. SUMMARY OF RADIATION EXPOSURE OF PERSONNEL (01/01/15 - 12/31/15)

The personnel radiation monitoring program at the University of Wisconsin for the past calendar year used Landauer Luxel brand monitors for whole body and extremity exposure. No personnel received any significant radiation exposure for the above period. The highest annual doses recorded were 20 mrem to the whole body and 40 mrem to the extremities.

The highest dose received by a member of the public visiting the reactor lab was 2.101 mrem, as measured by Siemens brand Electronic Personal Dosimeters.

Monthly radiation surveys continue to demonstrate acceptable radiation dose rates within the reactor laboratory and no contamination.

G. RESULTS OF ENVIRONMENTAL SURVEYS (01/01/15 - 12/31/15)

The environmental monitoring program at the University uses Landauer Luxel brand area monitors located in areas surrounding the reactor laboratory. Table 1 indicates the dose a person would have received if continuously present in the indicated area for the entire 2015 calendar year.

H. RADIOACTIVE EFFLUENTS

1. LIQUID EFFLUENTS

No liquid waste was discharged to the sanitary sewer from the facility during the year.

No liquid effluents were released to the environment during the year.

2. EXHAUST EFFLUENTS

Table 2 presents information on stack discharges during the year.

3. SOLID WASTE

No solid waste was transferred from the facility during the year.

TABLE 1 ANNUAL ENVIRONMENTAL MONITORING DOSE DATA (01/01/15 - 12/31/15)

Location	Annual Dose (mrem)
Dose Inside Reactor Laboratory Stack	<1
Highest Dose in Non-restricted Area	24
Highest Dose in Occupied* Non-restricted Area	23
Average Dose in all Non-restricted Areas (26 Monitor Points)	5.00

*Occupied areas include classrooms, offices, and lobbies/meeting areas where an individual might reasonably spend in excess of 2 hours per day

TABLE 2 EFFLUENT FROM STACK

1. Particulate Activity

There was no discharge of particulate activity above background levels.

2. Gaseous Activity - All Argon-41

Month	Activity Discharged (Curies)	Maximum Concentration (µCi/ml)	Average Concentration (µCi/ml)
July 2015	0.085	4.121E-07	5.253E-09
August	0.037	2.720E-07	2.269E-09
September	0.055	3.850E-07	3.467E-09
October	0.106	5.070E-07	6.460E-09
November	0.030	3.126E-07	1.851E-09
December	0.033	2.600E-07	1.970E-09
January 2016	0.028	3.055E-07	1.649E-09
February	0.007	2.790E-07	4.284E-10
March	0.013	2.790E-07	7.779E-10
April	0.009	2.920E-07	5.582E-10
May	0.012	2.480E-07	7.517E-10
June	0.000	0.000E+0	0.000E+00
	Total	Maximum	Average
	0.415	5.070E-7	2.120E-9

Using the Gaussian Plume model, as described in section 13.1.7.2 of the "Safety Analysis Report for the University of Wisconsin Nuclear Reactor", a concentration of 6E-5 µCi/ml at the stack discharge would result in a maximum air concentration of 1E-8 µCi/ml at any point downwind.