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License R-74
Docket 50-156

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

Enclosed is a copy of the 2021-2022 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, Paulette Torres
Reactor Safety Committee, RSC 1490

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NRR

THE UNIVERSITY OF WISCONSIN
NUCLEAR REACTOR LABORATORY

FISCAL YEAR 2021-2022 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
College of Engineering

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A. SUMMARY OF OPERATIONS

1. INSTRUCTIONAL USE

Nuclear Engineering (NE) 231, "Introduction to Nuclear Engineering" was offered in the spring semester with an enrollment of 13 students. The course was redesigned to incorporate an engineering design challenge utilizing the reactor. The students designed, manufactured, and tested a light-sensitive detector to measure the Cherenkov radiation emitted from the reactor. The students then determined how that data correlated with the actual reactor power level.

Eleven students participated in NE 234, "Principles and Practice of Nuclear Reactor Operation" during the fall semester. This course uses the reactor extensively, over 100 hours of reactor use specifically for training were required to provide this operating experience.

Three sections of NE 427, "Nuclear Instrumentation Laboratory", were offered during the academic year with a total enrollment of 22 students. Several NE 427 experiments use materials that are activated in the reactor. One experiment requires students to make measurements of radiation levels in the Reactor Laboratory.

Two sections of NE 428, "Nuclear Reactor Laboratory", were offered during the academic year with a total enrollment of 19 students. Three experiments require exclusive use of the reactor ("Critical Experiment", "Control Element Calibration", and "Pulsing") requiring a total of 18 hours of exclusive reactor use. Other laboratory sessions use material that have been irradiated in the reactor ("Fast Neutron Flux Measurements" and "Resonance Absorption").

Individual class sections for NE 305, "Fundamentals of Nuclear Engineering" and NE 424, "Nuclear Materials Laboratory" were held at the Reactor Laboratory, with 28 students participating.

The Reactor Laboratory continues its commitment to educational outreach programs and community service. A listing of individual schools and educational programs that 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 32

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

Badger Summer Pre-College Program 7

A reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor in support of an immersive college-prep program for students completing grades 9-12.

Beloit College 0

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

Boy Scouts of America 137

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 (ANS) in support of the Scouts Atomic Energy Merit Badge program.

Georgia Institute of Technology 2

Reactor tour with a discussion on the capabilities of the UW nuclear reactor and future collaborations.

Madison College 8

Radiation safety training program for Madison College's Hazardous Materials Chemistry course. Provided a hands-on laboratory experience to investigate the nature of radiation and radioactivity including use of detection equipment, the nature of alpha, beta and gamma radiation, various shielding material, demonstration of the $1/r^2$ nature of radiation point sources, and how to conduct a contamination survey.

Sandia National Laboratories 3

Reactor tour with a discussion on the capabilities of the UW nuclear reactor and future collaborations.

Participating Institution	Number of Participants

Society of Women Engineers 12

Student engineering society promoting women's roles in engineering programs. Visit included a reactor tour and talks with high school students about career options in nuclear science and engineering.

University of Illinois - Champaign-Urbana 13

Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of the ANS student conference.

UW College of Engineering
Graduate Student Safety Seminar 14

Reactor tour with a discussion on radiation and reactor safety in support of graduate research in the College of Engineering.

UW Engineering Physics Department
Graduate Student Recruitment Program 11

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

UW Engineering Physics Department
Department Open Houses 20

Reactor tours with a discussion on the capabilities and uses of the UW nuclear reactor and the UW nuclear engineering program fostering community engagement and undergraduate recruitment.

UW-Whitewater 0
Department of Physics

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

Wisconsin Community Energy Workshop 6

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

Wisconsin Foundation and Alumni Association 8

Reactor tour with a discussion on the current capabilities and uses of the UW nuclear reactor to returning alumni.

Participating Institution Number of Participants

Wisconsin Public Utility Institute (WPUI)
A virtual reactor tour with a discussion of current nuclear engineering research being conducted at the facility. WPUI's mission is to advance understanding and discussion of relevant topics in the utility industries by accessing experts and current research to create opportunities for discussion and debate in non-partisan program formats.

Wisconsin Society of Professional Engineers 11
Engineering professional development program. Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.

Women in Science and Engineering (WISE) 14
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. WISE is a learning community where women interested in science, technology, engineering, or math build strong connections with each other and UW-Madison staff and faculty who share their interests.

OUTREACH AND COMMUNITY SERVICE USER SUMMARY:

Organizations: 18
Participants: 298

3. IRRADIATION SERVICES

There were 227 individual samples irradiated during the year. Samples accumulated 90.5 irradiation space hours and 258.2 sample hours. Experiments accumulated 9.6 hours of neutron irradiation.

Department of Engineering Physics, UW-Madison
NE 231
2.0 hours of neutron irradiation
Following a course redesigned to incorporate an engineering design challenge utilizing the reactor, students designed, manufactured, and tested a light-sensitive detector to measure the Cherenkov radiation emitted from the reactor while operating. The students correlated the detector data to the actual reactor power level.

Department of Engineering Physics, UW-Madison
NE 427

114 samples, 113.0 sample hours
Production of foil sources for radiation detector experiments and activation of samples for the neutron activation analysis experiment.

Department of Engineering Physics, UW-Madison
NE 428

23 samples, 23.7 sample hours
Irradiation of foils for resonance absorption measurements and fast neutron flux measurements.

UW Nuclear Reactor Laboratory

33 samples, 23.1 sample hours
Production of calibration sources for required reactor measurements, flux measurements and development of methods for instrumental neutron activation analysis.

NorthStar Medical Radioisotopes, LLC

25 samples, 91.0 sample hours
Irradiation of radiopharmaceutical samples to refine production techniques.

SHINE Medical Technologies

32 samples, 7.4 sample hours
Irradiation of radiopharmaceutical samples to refine production techniques.

Vega Wave Systems, Inc.

7.6 hours of neutron irradiation
Vega Wave Systems, Inc. has developed an advanced, ultra-radiation-hardened vision system capable of withstanding more than an order of magnitude more radiation than the maximum encountered during nuclear refueling. Irradiation services provided to demonstrate system survivability to neutron and gamma radiation.

4. CHANGES IN PERSONNEL, FACILITY AND PROCEDURES

Personnel changes during the year were as follows:

Effective April 20, 2022, pursuant to license amendment 18 to the facility license, Vice Chancellor for Finance and Administration Laurent Heller replaced Paul P.H. Wilson, chair of the department of Engineering Physics, as the ANSI/ANS-15.1 Level 1 individual responsible for the reactor facility's license. Subsequently, on April 21, 2022, Rob Cramer permanently replaced Laurent Heller as Vice Chancellor for Finance and Administration.

The following Reactor Operator License was terminated:

Name	License	Effective Date
Tomas A. Montenegro	OP-502593	July 9, 2021

The following individual was appointed as Reactor Operator:

Name	License	Effective Date
Jason J. Rusch	OP-504405	September 2, 2021

Facility changes reportable under 10 CFR 50.59 are detailed in section E of this report. Other changes to the facility included changing the source of the core inlet 74°F "System Temp Hi/Lo" annunciator input from the Core Inlet Monitor to the Main Console Recorder.

All procedures were reviewed with proposed revision approved by the Reactor Safety Committee. No changes to operating procedures related to reactor safety occurred during the year.

5. 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 make-up volume and pool water radioactivity. The pool leak surveillance program indicated that no water effluent had been released to the environment this year.

B. OPERATING STATISTICS AND FUEL EXPOSURE

Operating Period	Critical Hours	MW-Hours	Runs	Pulses
Fiscal Year 2021-2022	419.92	320.82	179	25
Cumulative TRIGA 30/20 LEU	3,935.68	2,565.92	1847	406

Core K21-R6 was operated throughout the year. The excess reactivity of this core was determined to be 3.913%ρ.

C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There was one automatic SCRAM during the year. On March 23, 2022, while performing a normal reactor startup, a reactor operator trainee inadvertently upranged picoammeter number 2 two ranges and immediately down ranged in an attempt to correct but accidently down ranged two ranges. By this time reactor power had reached the trip setpoint on the original range. As a result, a reactor SCRAM from a neutron high flux trip at 125% on the 100mW range occurred.

D. MAINTENANCE

The Preventive Maintenance Program continues to maintain equipment and systems in good condition. Routine demineralizer regeneration occurred on April 1, 2022.

Corrective maintenance performed as a follow up action necessary for reactor restart following an emergency shutdown or 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 Safety Analysis Report (SAR):

On September 29, 2021, during completion of the UWNR 110, Daily Reactor Pre-Startup Check List, the fuel temperature safety channel (19M1) entered programming mode without operator intervention. Suspecting an age-related power supply or electrolytic capacitor failure the in-service monitor was removed from service and replaced with the spare. Following calibration, the fuel temperature safety channel was returned to service.

On February 1, 2022, during completion of the UWNR 171 Stack Air Monitor (SAM) and Continuous Air Monitor (CAM) Calibration Procedure the SAM lost power. Upon restoration of power the particulate channel failed to return to service. Troubleshooting revealed the NVRAM battery module failed. The spare SAM cart was put in service and calibrated while waiting for the replacement battery module. Subsequently on February 16, 2022, the in-service spare SAM cart gas channel failed. Troubleshooting revealed condensation on the inside of the sealed gas filled proportional detector. The detector was replaced and following calibration, the SAM was returned to service.

On March 28, 2022, the Continuous Air Monitor (CAM) vacuum pump failed. It was replaced with a spare and the system was restored to service.

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

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

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

There were two experiments approved pursuant to 10 CFR 50.59 during the year. The safety evaluation of each experiment concluded a license amendment pursuant to 10 CFR 50.90 was not required. Each experiment is summarized below.

One experiment consists of a fiber optic camera system mounted in a modified watertight aluminum housing. The watertight aluminum housing is of similar construction and

design as previously approved. This experiment is designed to irradiate and test the survivability of a new generation of video digital cameras for use in ultra-high radiation dose and dose rate environments.

The second experiment consists of photo diodes in a 12-foot-long dry poly tube sealed with a transparent end cap to measure the intensity of the Cherenkov radiation emitted from the reactor as part of a nuclear engineering freshman design course.

F. SUMMARY OF RADIATION EXPOSURE OF PERSONNEL (01/01/21 - 12/31/21)

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 whole-body doses recorded were 38 mrem deep dose equivalent (DDE) and 40 mrem shallow dose equivalent (SDE). The highest annual extremity dose was 16 mrem and the highest annual dose to the lens of the eye was 40 mrem.

The highest dose received by a member of the public visiting the reactor lab was 1.56 mrem, as measured by Mirion brand, model DMC 3000 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 (01/01/21 - 12/31/21)

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 2021 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

Solid waste transferred from the facility during the year are detailed in Table 3.

TABLE 1 ANNUAL ENVIRONMENTAL MONITORING DOSE DATA (01/01/21 - 12/31/21)

Location	Annual Dose (mrem)
Dose Inside Reactor Laboratory Stack	<1
Highest Dose in Non-restricted Area	38
Highest Dose in Occupied* Non-restricted Area	38
Average Dose in all Non-restricted Areas (26 Monitor Points)	4.87

*Occupied areas include classrooms, offices, and lobbies/meeting areas where an individual might reasonably spend more than 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 2021	0.026	3.940E-07	1.550E-09
August	0.045	2.920E-07	2.667E-09
September	0.088	4.520E-07	5.534E-09
October	0.080	5.690E-07	4.910E-09
November	0.076	2.985E-07	4.824E-09
December	0.031	2.786E-07	1.911E-09
January 2022	0.004	2.770E-07	2.138E-10
February	0.124	5.190E-07	8.354E-09
March	0.286	7.500E-07	1.728E-08
April	0.260	7.000E-07	1.631E-08
May	0.489	7.160E-07	2.960E-08
June	0.043	4.030E-07	2.683E-09
	Total	Maximum	Average
	1.552	7.500E-07	7.987E-09

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.

TABLE 3 SOLID WASTE

Date:	11/21/21	04/11/22	**TOTAL VOLUME**
Volume:	8.0 ft^3	19.4 ft^3	27.4 ft^3
Constituents:	Resins	Routine Consumables	
Isotope	Activity (mCi)	Activity (mCi)	Total Activity by Isotope (mCi)
Co-60	0.0154	0.0500	0.0654
Eu-152	0.0004		0.0004
Mn-54	0.0002	0.0210	0.0212
Total Activity per Transfer	0.0160 mCi	0.0710 mCi	**TOTAL ACTIVITY** 0.0870 mCi

All activity transferred from the facility to the University of Wisconsin Broadscope License, license number WI-1323-1.