



Nuclear Reactor Laboratory

University of Wisconsin-Madison

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

Enclosed is a copy of the 2022-2023 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 1518

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NRR

**THE UNIVERSITY OF WISCONSIN
NUCLEAR REACTOR LABORATORY**

FISCAL YEAR 2022-2023 ANNUAL OPERATING REPORT

Prepared to meet reporting requirements of:

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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 25 students. The course incorporates 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.

Two sections of NE 427, "Nuclear Instrumentation Laboratory", were offered during the academic year with a total enrollment of 25 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 18 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 materials that have been irradiated in the reactor ("Fast Neutron Flux Measurements" and "Resonance Absorption").

Individual class sections for NE 305, "Fundamentals of Nuclear Engineering", NE 424, "Nuclear Materials Laboratory", EP 469, "Research in Engineering Physics", EP 568, "Research Practicum I" and EP 569, "Research Practicum II" were held at the Reactor Laboratory, with 41 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

<u>Participating Institution</u>	<u>Number of Participants</u>
American Society of Mechanical Engineers	
UW-Madison Student Branch	12
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Argonne National Laboratory	12
A reactor tour as part of a course on nuclear reactor fundamentals for government employees.	
Badger Summer Pre-College Program	11
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	120
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.	
Collaboratory for Engineering Education and Teaching Excellence	4
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Consortium for Enabling Technologies and Innovation	23
Reactor tour with a discussion on research capabilities of the UW nuclear reactor. The core mission of the ETI is to bridge the gap between the university basic research and NNSA national laboratories' mission.	

<u>Participating Institution</u>	<u>Number of Participants</u>
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Davis-Bahcall Scholars**Black Hills State University**

10

Reactor tour with a discussion of the nuclear processes during fission. The Davis-Bahcall Scholars Program is a program for South Dakota high school seniors or college freshmen exploring the world of modern scientific research at the Sanford Underground Research Facility. The program includes a road trip to the Soudan Underground Laboratory and NOVA facility in Minnesota, UW-Madison, Argonne National Laboratory and Fermilab in Illinois.

Department of Energy**Horizon-broadening Isotope Production Pipeline Opportunities (HIPPO) Program**

11

Reactor tour with a discussion on isotope production capabilities at the UW nuclear reactor. The HIPPO program aims to develop the future isotope production workforce for the nation and the DOE Isotope Program.

Gender Minorities and Women in Physics (GMAWiP)**UW-Madison Student Branch**

6

Reactor tour with a discussion on research capabilities of the UW nuclear reactor.

Mount Horeb High School

40

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

North Central Chapter of Health Physics Society

9

Reactor tour with a discussion on research capabilities of the UW nuclear reactor.

Nuclear Innovation Bootcamp

24

Reactor tour with discussion on nuclear energy as a clean energy source. The Nuclear Innovation Bootcamp equips a select group of students and early-career professionals with the tools and understanding needed to approach the clean energy challenges of today and tomorrow.

<u>Participating Institution</u>	<u>Number of Participants</u>
ProCSI: Promoting Computational Science Initiative	22
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. ProCSI introduces high-school students to the computational science discipline where participants are shown how the fundamental building blocks they are currently learning in high-school math, physics, and science classes are connected to advanced concepts in computer science and engineering.	
Saint John's School	15
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Sauk Prairie High School	7
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
SHINE	3
Reactor tour with a discussion on services provided by the UW nuclear reactor.	
State of Wisconsin Department of Health & Family Services Radiation Protection Division	9
Reactor tour with a discussion on emergency planning for the UW nuclear reactor.	
State of Wisconsin Legislature	18
Reactor tour with a discussion on the economic impacts of the UW nuclear reactor on the State of Wisconsin.	
UW College of Engineering Computer Aided Engineering Department	8
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
UW College of Engineering Graduate Student Safety Seminar	31
Reactor tour with a discussion on radiation and reactor safety in support of graduate research in the College of Engineering.	

<u>Participating Institution</u>	<u>Number of Participants</u>
UW College of Engineering	
Mechanical Engineering Department	11
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
UW Engineering Physics Department	
Graduate Student Recruitment Program	13
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	103
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 Materials Research Science and Engineering Center	
Interdisciplinary Education Group	8
Reactor tour with a discussion on nuclear materials research at the UW nuclear reactor.	
UW Medical Physics Department	8
Reactor tour with a discussion on research capabilities of the UW nuclear reactor.	
UW Police Department	4
Awareness training including a discussion on reactor emergency preparedness and response procedures.	
UW-Oshkosh	
Office of International Education	17
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor for student from Korea.	
UW-Whitewater	
Department of Physics	0
Analyzed swipe tests to leak check radioactive sources and performed detector calibrations.	

<u>Participating Institution</u>	<u>Number of Participants</u>
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Verona Area High School	16
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	

Women in Science and Engineering (WISE)	56
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: 30

Participants: 631

3. IRRADIATION SERVICES

There were 203 individual samples irradiated during the year. Samples accumulated 95.7 irradiation space hours and 223.8 sample hours. Experiments accumulated 3.0 hours of neutron irradiation.

**Department of Engineering Physics, UW-Madison
NE 231**

3.0 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**

126 samples, 112.0 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**

24 samples, 28.0 sample hours
Irradiation of foils for resonance absorption measurements
and fast neutron flux measurements.

UW Nuclear Reactor Laboratory

13 samples, 6.9 sample hours
Production of calibration sources for required reactor
measurements, flux measurements and development of methods
for instrumental neutron activation analysis.

Charlotte Pipe Foundry

14 samples, 14.0 sample hours
Neutron activation analysis of samples containing antimony.

NorthStar Medical Radioisotopes, LLC

17 samples, 62.0 sample hours
Irradiation of radiopharmaceutical samples to refine
production techniques.

SHINE Medical Technologies

9 samples, 0.9 sample hours
Irradiation of radiopharmaceutical samples to refine
production techniques.

4. CHANGES IN PERSONNEL, FACILITY AND PROCEDURES

Personnel changes during the year were as follows:

The following Reactor Operator Licenses were terminated:

Name	License	Effective Date
Zackery Helgert	OP-503819	August 2, 2022
Anthony Boyd	OP-503820	August 2, 2022
Noah Bolling	OP-503822	August 2, 2022

The following individuals were appointed as Reactor Operators:

Name	License	Effective Date
Alison Q. Holden	OP-504875	August 19, 2022
Daniel P. Mancheski	OP-504876	August 19, 2022
Andrea N. Strzelec	OP-504877	August 19, 2022

Facility changes reportable under 10 CFR 50.59 are detailed in section E of this report. There were no other changes to the facility during the year.

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 2022-2023	303.38	224.47	72	30
Cumulative TRIGA 30/20 LEU	4,239.06	2,790.39	1919	436

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 emergency manual SCRAM during the year. On October 6, 2022, while performing a normal reactor startup, a reactor operator received a short period alarm. The operator implemented the immediate actions of the UWNR 156, Unexpected Shift in Reactivity by inserting a manual SCRAM. Upon further investigation it was determined the operator had lost operational awareness and had unintentionally inserted sufficient reactivity manually to trip the short period alarm.

D. MAINTENANCE

The Preventive Maintenance Program continues to maintain equipment and systems in good condition. Routine demineralizer regeneration occurred on October 12, 2022 and May 25, 2023.

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 August 1, 2022 and May 12, 2023 the Stack Air Monitor (SAM) experienced a Trouble fault. In both events, troubleshooting determined the particulate channel background detector had failed. The detectors were replaced, the channel calibrated and returned to service.

On October 27, 2022, during completion of the UWNR 110, Daily Reactor Pre-Startup Check List, the Pneumatic Sample Transfer System (PSTS) blower failed to start when the system was turned on. Troubleshooting revealed the solid-state relay used to allow the low voltage DC demand circuit to load the high voltage AC motor starter failed. The relay was replaced, and the system was returned to service.

On April 17, 2023, during completion of the UWNR 121, Ventilation System Operating Procedure, the lead fan failed

to start when the ON/OFF/AUTO toggle switch was in the ON position. Troubleshooting revealed that the toggle switch had failed. The switch was replaced. The system was tested to confirm it was operable and returned 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 no new experiments, reportable pursuant to 10 CFR 50.59, conducted during the year.

F. SUMMARY OF RADIATION EXPOSURE OF PERSONNEL (01/01/22 - 12/31/22)

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 34 mrem deep dose equivalent (DDE) and 35 mrem shallow dose equivalent (SDE). The highest annual extremity dose was 56 mrem and the highest annual dose to the lens of the eye was 34 mrem.

The highest dose received by a member of the public visiting the reactor lab was 0.18 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
(01/01/22 - 12/31/22)

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 2022 calendar year.

H. RADIOACTIVE EFFLUENTS

1. LIQUID EFFLUENTS

Liquid waste discharged to the sanitary sewer from the facility during the year is detailed in Table 2.

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

2. EXHAUST EFFLUENTS

Table 3 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
(01/01/22 - 12/31/22)

Location	Annual Dose (mrem)
Dose Inside Reactor Laboratory Stack	<1
Highest Dose in Non-restricted Area	22
Highest Dose in Occupied* Non-restricted Area	22
Average Dose in all Non-restricted Areas (26 Monitor Points)	2.78

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

TABLE 2 LIQUID RADIOACTIVE WASTE DISCHARGED TO SEWER

Release Date:	<u>10/06/2022</u>	<u>05/22/2023</u>
Gallons Released:	971	923
Total µCi:	10.73	15.58
Sum of Fraction of MPC w/o dilution:	4.613E-02	6.851E-02
Sum of Fraction of MPC w/ daily dilution:	1.884E-03	2.660E-03

<u>Isotope</u>	<u>MPC</u> <u>(µCi/ml)</u>	<u>Released</u>	<u>Released</u>	
Co-58	2.00E-04	1.589E+00	1.983E+00	µCi
		4.324E-07	5.676E-07	µCi/ml
		2.162E-03	2.838E-03	Fraction of MPC
Co-60	3.00E-05	4.371E+00	6.138E+00	µCi
		1.189E-06	1.757E-06	µCi/ml
		3.964E-02	5.856E-02	Fraction of MPC
Mn-54	3.00E-04	4.768E+00	7.460E+00	µCi
		1.297E-06	2.135E-06	µCi/ml
		4.324E-03	7.117E-03	Fraction of MPC

Annual total volume of water released to the sanitary sewer (gallons)	=	1894
Annual total activity released to the sanitary sewer (µCi)	=	26.31
Average daily sewage flow for dilution (gallons)	=	2.370E+04
Annual sum of fraction of MONTHLY release limit with DAILY dilution	=	4.544E-03
Annual sum of fraction of MONTHLY release limit with MONTHLY dilution	=	1.493E-04

TABLE 3 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 ($\mu\text{Ci/ml}$)	Average Concentration ($\mu\text{Ci/ml}$)
July 2022	0.077	4.120E-07	4.615E-09
August	0.111	4.620E-07	6.823E-09
September	0.298	7.000E-07	1.881E-08
October	0.168	4.520E-07	1.042E-08
November	0.152	5.430E-07	9.685E-09
December	0.191	5.820E-07	1.164E-08
January 2023	0.023	5.310E-07	1.424E-09
February	0.114	6.380E-07	7.728E-09
March	0.168	8.810E-07	1.030E-08
April	0.150	1.010E-06	9.663E-09
May	0.053	4.840E-07	3.299E-09
June	0.030	3.510E-07	1.984E-09
	<u>Total</u>	<u>Maximum</u>	<u>Average</u>
	1.535	1.010E-06	8.033E-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 $6\text{E-}5$ $\mu\text{Ci/ml}$ at the stack discharge would result in a maximum air concentration of $1\text{E-}8$ $\mu\text{Ci/ml}$ at any point downwind.