

# Nuclear Reactor Laboratory

**UWNR** University of Wisconsin-Madison

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License R-74  
Docket 50-156

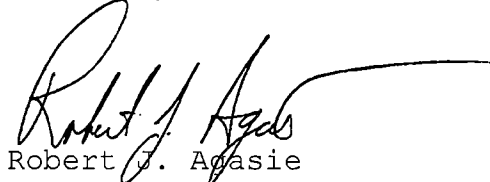
September 2, 2021

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

Dear Sir:

Enclosed is a copy of the 2020-2021 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, William Kennedy  
Reactor Safety Committee, RSC 1447

A020  
NRR

**THE UNIVERSITY OF WISCONSIN  
NUCLEAR REACTOR LABORATORY**

FISCAL YEAR 2020-2021 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**

Despite the COVID-19 pandemic, three sections of NE 427, Nuclear Instrumentation Laboratory, were offered during the academic calendar year with a total enrollment of 23 students. Several NE 427 experiments use materials that are activated in the reactor. One experiment entitled "Radiation Survey" requires students to make measurements of radiation levels in and around the Reactor Laboratory.

Two sections of NE 428, Nuclear Reactor Laboratory, were offered during the academic calendar year with a total enrollment of 23 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").

One laboratory session of NE 424, Nuclear Materials Laboratory, was conducted in the Reactor Laboratory to demonstrate the principles and practice of nuclear counting following material irradiations in the reactor. Four students were enrolled in the laboratory section.

The Reactor Laboratory continues its commitment to educational outreach programs and community service. As a result of the COVID-19 pandemic outreach was limited to providing services and virtual tours. 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

#### **Abundant Life Christian High School**

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

#### **Beloit College**

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

#### **UW-Whitewater**

##### **Department of Physics**

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

#### **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.

## 3. IRRADIATION SERVICES

There were 641 individual samples irradiated during the year. Samples accumulated 180.0 irradiation space hours and 718.0 sample hours.

#### **Department of Anthropology, UW-Madison**

421 samples, 452.5 sample hours

Instrumental Neutron Activation Analysis (INAA) to characterize fragments of steatite manufacturing debris excavated from the archaeological site of Harappa, Pakistan.

#### **Department of Engineering Physics, UW-Madison**

##### **NE 427**

112 samples, 62.0 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**

22 samples, 23.5 sample hours  
Irradiation of foils for resonance absorption measurements  
and fast neutron flux measurements.

**Department of Engineering Physics, UW-Madison  
UW Nuclear Reactor Laboratory**

18 samples, 28.0 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**

18 samples, 72.0 sample hours  
Irradiation of radiopharmaceutical samples to refine  
production techniques.

**SHINE Medical Technologies**

49 samples, 79.9 sample hours  
Irradiation of radiopharmaceutical samples to refine  
production techniques.

**University of Colorado  
Anschutz Medical Campus**

1 sample, 0.1 sample hours  
Irradiation of metallic holmium foil to produce Ho-166 to  
investigate therapeutic radioactive skin patches used for  
the treatment of non-melanoma skin cancers.

**4. CHANGES IN PERSONNEL, FACILITY AND PROCEDURES**

Personnel changes during the year were as follows:

The following Reactor Operator License was terminated:

Name	License	Effective Date
John D. Masse	OP-502592	August 14, 2020

Facility changes reportable under 10 CFR 50.59 are detailed  
in section E of this report. Other changes to the facility  
included the installation of an automatic pool heater to

maintain pool water temperature during periods of time when the reactor is not operating.

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 2020-2021	416.33	327.08	153	21
Cumulative TRIGA 30/20 LEU	3,515.76	2,245.10	1668	381

Core K21-R6 was operated throughout the year. The excess reactivity of this core was determined to be 3.944%p.

## C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There was one automatic SCRAM during the year. On December 15, 2020, the core inlet temperature was right at the low-level alarm setpoint. The Core Inlet Monitor was not in alarm; however, the recorder channel for the core inlet temperature did show a low temperature alarm condition. The on-duty reactor operator attempted to acknowledge the

recorder alarm by depressing the Core Inlet Monitor trip reset. This had the effect of resetting the Core Inlet Monitor and temporarily opening the Core Inlet Monitor trip relay thereby initiating a reactor SCRAM.

#### **D. MAINTENANCE**

The Preventive Maintenance Program continues to maintain equipment and systems in good condition. Routine demineralizer regeneration occurred on August 21, 2020, and exhausted resins were replaced on March 2, 2021.

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 12, 2020, the front panel display of the High Voltage Power Supply (HVPS) did not match the setpoint pot. Troubleshooting revealed the connectors to the front panel display had come partially loose. The connectors were reseated, and the display functioned properly.

On September 1, 2020, the Continuous Air Monitor (CAM) gas channel went into alarm reading full scale. Troubleshooting revealed the sealed gas proportional detector failed. The detector was replaced and following calibration, the CAM was returned to service.

On November 16, 2020, during weekly Area Radiation Monitor (ARM) checks, the bridge ARM stopped responding. Troubleshooting revealed the 22Mohm resistor R213 had failed. The resistor was replaced. Following calibration, the ARM was returned to service.

On April 21, 2021, during completion of the UWNR 122, Surveillance SCRAM Checks procedure, the High Voltage (HV) Monitor relay did not close again when HVPS was returned to 500V. Troubleshooting revealed the 12-volt DC power supply to the HV Monitor had failed. A new 12-volt DC power supply was installed with an identical spare. The HV Monitor was tested and returned to service.



On April 26, 2021, during completion of the UWNR 165, Procedure for Primary System Resistivity Control, the demineralizer flow rate was observed to be lower than normal and erratic. Troubleshooting revealed the flow meter had failed. The flow meter was rebuilt, tested 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 (01/01/20 - 12/31/20)**

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 24 mrem deep dose equivalent (DDE) and 30 mrem shallow dose equivalent (SDE). The highest annual extremity dose was 77 mrem and the highest annual dose to the lens of the eye was 27 mrem.

The highest dose received by a member of the public visiting the reactor lab was 0.22 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**  
**(01/01/20 - 12/31/20)**

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 2020 calendar year.

**H. RADIOACTIVE EFFLUENTS**

1. LIQUID EFFLUENTS

Liquid waste discharged to the sanitary sewer from the facility during the year are 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**  
**(01/01/20 - 12/31/20)**

Location	Annual Dose (mrem)
Dose Inside Reactor Laboratory Stack	<1
Highest Dose in Non-restricted Area	20
Highest Dose in Occupied* Non-restricted Area	20
Average Dose in all Non-restricted Areas (26 Monitor Points)	2.83

\*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>8/13/2020</u>	<u>2/22/2021</u>	
Gallons Released:		1122	929	
Total $\mu\text{Ci}$ :		2.873	35.24	
Sum of Fraction of MPC w/o dilution:		2.081E-02	3.326E-01	
Sum of Fraction of MPC w/ daily dilution:		9.819E-04	1.300E-02	
<u>Isotope</u>	<u>MPC</u> <u>(<math>\mu\text{Ci}/\text{ml}</math>)</u>	<u>Released</u>	<u>Released</u>	
Co-58	2.00E-04	2.606E-01		$\mu\text{Ci}$
		6.135E-08		$\mu\text{Ci}/\text{ml}$
		3.068E-04		Fraction of MPC
Co-60	3.00E-05	2.612E+00	3.507E+01	$\mu\text{Ci}$
		6.150E-07	9.973E-06	$\mu\text{Ci}/\text{ml}$
		2.050E-02	3.324E-01	Fraction of MPC
Mn-54	3.00E-04		1.730E-01	$\mu\text{Ci}$
			4.919E-08	$\mu\text{Ci}/\text{ml}$
			1.640E-04	Fraction of MPC
Annual total volume of water released to the sanitary sewer (gallons)				= 2051
Annual total activity released to the sanitary sewer ( $\mu\text{Ci}$ )				= 38.11
Average daily sewage flow for dilution (gallons)				= 2.370E+04
Annual sum of fraction of MONTHLY release limit with DAILY dilution				= 1.398E-02
Annual sum of fraction of MONTHLY release limit with MONTHLY dilution				= 4.592E-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 ( $\mu\text{Ci}/\text{ml}$ )	Average Concentration ( $\mu\text{Ci}/\text{ml}$ )
July 2020	0.048	3.270E-07	2.836E-09
August	0.014	2.720E-07	8.174E-10
September	0.075	7.330E-07	4.548E-09
October	0.244	4.420E-07	1.502E-08
November	0.140	4.030E-07	8.756E-09
December	0.167	3.760E-07	1.010E-08
January 2021	0.033	4.120E-07	2.161E-09
February	0.049	3.670E-07	3.227E-09
March	0.029	3.130E-07	1.758E-09
April	0.063	4.220E-07	3.918E-09
May	0.029	2.210E-07	1.729E-09
June	0.024	1.720E-07	1.502E-09
	<u>Total</u>	<u>Maximum</u>	<u>Average</u>
	0.915	7.330E-07	4.698E-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  $6\text{E}-5$   $\mu\text{Ci}/\text{ml}$  at the stack discharge would result in a maximum air concentration of  $1\text{E}-8$   $\mu\text{Ci}/\text{ml}$  at any point downwind.