



Nuclear Reactor Laboratory

University of Wisconsin-Madison

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License R-74
Docket 50-156

August 9, 2013

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

Dear Sir:

Enclosed is a copy of the 2012-2013 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, Geoffrey A. Wertz
Reactor Safety Committee, RSC 1169

A020
MRR

**THE UNIVERSITY OF WISCONSIN
NUCLEAR REACTOR LABORATORY**

FISCAL YEAR 2012-2013 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



EXECUTIVE SUMMARY OF REACTOR UTILIZATION

Instruction: Teaching usage of the reactor during the year included:

- 131 Nuclear Engineering students in laboratory and lecture courses.
- 36 students and staff from other UW-Madison departments and programs.
- 711 individuals from 16 organizations as part of the UW Nuclear Reactor Outreach Program.

Research: Neutron irradiations during the year included:

- 207 samples irradiated for departments at UW-Madison.
- 48 samples were irradiated for other educational and research institution research programs.

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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 30 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.

Two sections of NE 427 were offered in the fall and spring semesters with a total enrollment of 48 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.

Two sections of NE 428 were offered in the fall and spring semester with a total enrollment of 41 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").

A new course entitled "Detection and Remediation of Radionuclides in the Environment" was developed in collaboration with Civil and Environmental Engineering. The cross listed course, NE 602/CEE 629, was offered in the spring of 2013 with 16 students participating. More details about this new course can be found in section A.4 of this report below.

Individual class sections for Anthropology 311, "Archaeological Chemistry", and Medical Physics 569, "Health Physics" were held at the Reactor Laboratory, with 32 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

<u>Participating Institution</u>	<u>Number of Participants</u>
Abundant Life Christian High School	20
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Argyle High School	6
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Barneveld High School	6
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Beaver Dam High School	41
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Beloit College	0
Analyzed swipe tests to leak check radioactive sources and performed detector calibrations.	
Boy Scouts of America	405
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.	

<u>Participating Institution</u>	<u>Number of Participants</u>
Capital Science & Engineering Fair	16
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor. Part of the Capital Science & Engineering Fair which was established to provide high school students from South Central Wisconsin a unique opportunity to perform science and engineering and learn from University faculty and staff.	
Dane County Emergency Management	12
Reactor tour with a discussion on emergency planning for the UW nuclear reactor.	
Girl Scouts of the USA	39
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 Girl Scouts Atomic Merit Badge.	
Pecatonia High School	7
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	
Spring Harbor Middle School	96
Provided lecture to students on nuclear energy and a reactor demonstration using remote distance education technology as described in section A.4 of this report.	
State Engineering University of Armenia Yerevan, Armenia	24
Provided laboratory course to nuclear engineering students in Yerevan, Armenia using remote distance education technology as described in section A.4 of this report.	
UW Energy Institute	7
Reactor tour with a discussion on applications of nuclear energy and uses of the UW nuclear reactor.	

<u>Participating Institution</u>	<u>Number of Participants</u>
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UW Engineering Physics Department

Graduate Student Recruitment Program	21
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Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor in support of graduate research recruitment program.

UW - Materials Research Science & Engineering Center

	11
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Reactor tour with a discussion on the capabilities and uses of the UW nuclear reactor. The UW MRSEC Education Group (IEG) creates and distributes a broad range of educational products that are widely used for K-12 and college-level instruction on topics that build on the center's materials science discoveries and expertise.

UW-Whitewater

Department of Physics	0
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Analyzed swipe tests to leak check radioactive sources and performed detector calibrations.

OUTREACH AND COMMUNITY SERVICE USER SUMMARY:

Organizations:	16
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Participants:	711
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3. SAMPLE IRRADIATIONS AND NEUTRON ACTIVATION ANALYSIS SERVICES

There were 255 individual samples irradiated during the year. Of these samples, 138 were irradiated for 15 minutes or less. Samples accumulated 58.7 irradiation space hours and 299.2 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

3 samples, 4.1 sample hours

Irradiation of silicon dioxide to induce damage that will change the electrical properties of the material.

Department of Engineering Physics, UW-Madison

NE 602

Department of Civil & Environmental Engineering, UW-Madison

CEE 629

6 samples, 0.6 sample hours

Irradiation of foil sources for radiation detector experiments for a new course in radiation detection and remediation in the environment.

Department of Engineering Physics, UW-Madison

Instrumentation Laboratory

171 samples, 172.5 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

22 samples, 23.7 sample hours

Irradiation of foils for resonance absorption measurements and fast neutron flux measurements.

Department of Engineering Physics, UW-Madison

UW Nuclear Reactor Laboratory

4 samples, 2.2 sample hours

Production of calibration sources for required reactor measurements and development of methods for instrumental neutron activation analysis.

Department of Medical Physics, UW-Madison

23 samples, 25.1 sample hours

Irradiation of copper foils to explore the viability of using thin metal foils as personnel neutron dosimeter.

**United States Geological Survey (USGS)
University of Denver**

(NAA)

48 samples, 96 sample hours

NAA supporting a thesis project in sedimentology of the Ziegler Reservoir in Snowmass, Colorado. The hypothesis is that the sediments were primarily wind transported and thus may hold a record of past climates.

4. OTHER MAJOR EDUCATIONAL, RESEARCH, & OPERATIONAL ACTIVITIES

In December 2012 the facility conducted reactor demonstrations "offered at a distance" with Spring Harbor Middle School in Madison, WI. Over 95 children participated in a lecture and demonstration that was broadcast over the internet. Adobe Connect Pro software was utilized to connect the Spring Harbor Middle School with the UW Nuclear Reactor Lab. The reactor demonstration included a supercritical power excursion and demonstration of the prompt negative fuel temperature coefficient of reactivity that ended with a reactor scram to show the shutdown characteristics of a nuclear reactor.

In May 2013 the facility conducted a nuclear energy workshop "offered at a distance" with the State Engineering University of Armenia in Yerevan, Armenia. Approximately 24 students participated in 3 laboratory sessions over a 3 day period. Again, Adobe Connect Pro software was utilized to connect Yerevan with the UW Nuclear Reactor Lab. The reactor modules included an approach to critical, control element calibration and pulsing behavior of TRIGA reactors. This program was supported by the U.S. Department of Energy (DOE) via the International Nuclear Safety Program (INSP) and the Safety Analysis Capability (SAC) program managed by Argonne National Laboratory.

The remote connectivity capability described above was funded through a NRC Educational Curriculum Development Grant, entitled "Remote Nuclear Reactor Measurements Laboratory: Development of innovative web-based nuclear engineering measurement modules to be offered at a distance".

In the spring of 2013 a collaborative effort between the UW Nuclear Reactor and the UW Department of Civil and Environmental Engineering developed a new course in the detection and remediation of radionuclides in the environment. Sixteen students from both curricula participated in the course. The course focused on the fundamental and practical concepts in nuclear engineering and environmental engineering to educate students from both disciplines so that they can communicate with each other. The course included hands-on laboratory experiences in both disciplines. The course development was funded through a NRC Educational Curriculum Development Grant.

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 NLI-1000 analog output board with a new board that prevents negative currents on the 0 to 1 mA log power output to the main panel control board meter.

The facility voluntarily participated in the DOE/NNSA Global Threat Reduction Initiative (GTRI) program to enhance security in the auxiliary spaces surrounding the protected area.

Personnel changes during the year were as follows:

The following Reactor Operator Licenses were terminated:

Name	License	Effective Date
Samuel R. Maslonkowski	OP-71024	August 14, 2012
David J. Ozburn	OP-71025	March 18, 2013

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 approximately 70 gallons of water effluent has been released to the environment as detailed in table 2 below.

B. OPERATING STATISTICS AND FUEL EXPOSURE

Operating Period	Critical Hours	MW-Hrs	Runs	Pulses
Fiscal Year 2012-2013	300.97	235.06	86	28
Cumulative TRIGA 30/20 LEU	1,601.50	1,043.98	615	169

Core K21-R6 was operated throughout the year. The excess reactivity of this core was determined to be 4.183% ρ .

C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There were no automatic SCRAMS or manual emergency shutdowns during the year.

D. MAINTENANCE

The Preventive Maintenance Program continues to maintain equipment and systems in good condition. Routine replacement of demineralizer resins occurred on August 29, 2012.

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:

On May 5, 2013 while performing the pre-startup check list the blade disengaged annunciator would not clear nor would the #2 magnet engaged lamp illuminate even though the blade was coupled to the drive. Troubleshooting indicated the connection from the blade drive to the control console was at fault. Upon removing the shell of the plug, wire 234 was observed broken from the cup socket due to a cold solder joint. The wire was reconnected and the indication was verified to respond as expected.

During annual maintenance activities in June 2013 the switch which indicates the transient rod is fully inserted during SCRAM time testing was observed to have failed. The switch was replaced with an identical spare and tested successfully.

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 (01/01/12 - 12/31/12)

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 50 mrem to the extremities.

The highest dose received by a member of the public visiting the reactor lab was 0.67 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
(01/01/12 - 12/31/12)

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 2012 calendar year.

H. RADIOACTIVE EFFLUENTS

1. LIQUID EFFLUENTS

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

Liquid effluents released to the environment during the year are detailed in Table 2.

2. EXHAUST EFFLUENTS

Table 3 presents information on stack discharges during the year.

3. SOLID WASTE

There was no solid waste transferred from the facility during the year.

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

<u>Location</u>	<u>Annual Dose (mrem)</u>
Dose Inside Reactor Laboratory Stack	<1
Highest Dose in Non-restricted Area	4
Highest Dose in Occupied* Non-restricted Area	2
Average Dose in all Non-restricted Areas (26 Monitor Points)	0.3

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

TABLE 2 LIQUID EFFLUENT FROM POOL

Liquid Release to the Environment - All Activity H-3

Month	Water Released (Gallons)	Average Concentration ($\mu\text{Ci}/\text{ml}$)	Activity Released (mCi)	Fraction of MPC
July 2012	70	7.76E-5	0.021	0.078
August	0	7.84E-5	0.000	-
September	0	7.43E-5	0.000	-
October	0	6.81E-5	0.000	-
November	0	7.22E-5	0.000	-
December	0	7.57E-5	0.000	-
January 2013	0	7.03E-5	0.000	-
February	0	7.24E-5	0.000	-
March	0	7.43E-5	0.000	-
April	0	7.08E-5	0.000	-
May	0	6.84E-5	0.000	-
June	0	6.76E-5	0.000	-
	<u>Total</u>	<u>Average</u>	<u>Total</u>	<u>Average</u>
	70	7.25E-5	0.021	0.078

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 ($\mu\text{Ci/ml} \times 1\text{E-6}$)	Average Concentration ($\mu\text{Ci/ml} \times 1\text{E-6}$)
July 2012	0.043	1.170	0.003
August	0.000	0.000	0.000
September	0.539	1.530	0.037
October	0.602	0.780	0.040
November	0.404	1.173	0.026
December	0.138	0.980	0.009
January 2013	0.188	1.760	0.013
February	0.362	1.130	0.027
March	0.296	0.842	0.022
April	0.272	1.540	0.019
May	0.055	0.940	0.004
June	0.022	0.980	0.002
	<u>Total</u>	<u>Maximum</u>	<u>Average</u>
	2.920	1.760	0.018

Using the Gaussian Plume model, as described in section 13.1.7.2 of the "LEU Conversion 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.