ANNUAL OPERATING REPORT FOR LICENSE R-74

TO THE UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR

FISCAL YEAR 1982-1983

PREPARED BY: R. J. CASHWELL
DEPARTMENT OF NUCLEAR ENGINEERING

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UNIVERSITY OF WISCONSIN
NUCLEAR REACTOR LABORATORY

ANNUAL REPORT

A. SUMMARY OF OPERATIONS

1. INSTRUCTIONAL USE - UW-MADISON FORMAL CLASSES

Three Nuclear Engineering Department classes make use of the reactor. Forty-eight students enrolled in NE 231 participated in a two-hour laboratory session introducing students to reactor behavior characteristics. Twelve hours of reactor operating time were devoted to this session. NE 427 was offered in the fall semester and had an enrollment of sixteen. 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. The irradiations in support of NE 427 and the radiation survey take place during normal isotope production runs, so no reactor time is specifically devoted to NE 427. The enrollment in NE 428 was twenty-four, as it was offered in both semesters. Three experiments in NE 428 require exclusive use of the reactor. Each of these experiments ("Critical Experiment", "Control Element Calibration", and "Pulsing") was repeated four times during the year requiring a total of seventy-seven 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"). These two experiments were repeated eight times during the year. (Individual one- to two-hour sessions in the reactor laboratory were also held for other departments on campus.)

2. REACTOR SHARING PROGRAM

User institutions participated in the program as detailed in the following paragraphs:

Beloit College (Wis.)--Professor and 30 students. Two groups of students visited the reactor facility and participated in the Reactor Operation Demonstration to observe reactor subcritical, critical, supercritical, and prompt-subcritical behavior.

Carroll College (Wis.)--Professor and 3 advanced chemistry students visited the facility and performed a laboratory on neutron activation analysis.

Luther College (Iowa)--Professor and 15 students visited the laboratory for familiarization with the reactor and its neutron activation analysis capability.

Madison Area Technical College (Wis.)--Professor and 3 students visited the laboratory and participated in the Reactor Operation Demonstration.

South Dakota State University--Professor and 1 graduate student utilized the neutron activation analysis capability of the laboratory to study by trace element analysis of vegetatation, the effect of a sanitary landfill operation on the surrounding environment.

University of Minnesota-Duluth--Professor, 2 staff members, 2 graduate students continued work on NAA of archaeological artifacts.

University of Wisconsin-Eau Claire--Professor and 12 students visited the facility to perform a laboratory session on neutron activation analysis.

University of Wisconsin-Parkside--Professor and 6 students visited the facility for a laboratory session on neutron activation analysis.

University of Wisconsin-Platteville--Professor and 5 students visited the facility for a laboratory session on neutron activation analysis.

3. UTILITY PERSONNEL TRAINING

A group of six trainees from Millstone Point Unit 3 attended our two-week Research Reactor Training Program. Two of the trainees returned for an additional two-day review session. The program reinforces training in reactor physics and operation and gives laboratory experience in health physics and instrumentation.

4. SAMPLE IRRADIATIONS AND NEUTRON ACTIVATION ANALYSIS SERVICES

There were 7,878 samples irradiated during the year. There were 1,233 samples which received short (15 minutes or less) irradiations, while the remaining samples were irradiated in 743 separate irradiations, accumulating 696.88 irradiation space hours and 18,486.7 sample hours. Most of the samples were irradiated and subsequently counted at the laboratory as part of our neutron activation analysis service. In the listing below, the notation (NAA) indicates that the samples were processed by our neutron activation analysis service.

Biochemistry Department. (NAA) 229 samples, 19 less than 15 minutes, 20 irradiations, 3.58 irradiation space hours, 20 sample hours.

Professor Adler and 1 graduate student used the neutron activation analysis service to determine what elements were leached out of glass slides which may have interfered with some analyses which they were performing.

Center for Great Lakes Studies-UW-Milwaukee. (NAA) 46 samples, 46 less than 15 minutes, 46 irradiations, 3.83 irradiation space hours.

Professor Bertram began a study of selenium content of flat head minnows to determine possible effects of polution sources.

Chemistry Department. (NAA) 144 samples, 41 less than 15 minutes, 52 irradiations, 7.48 irradiation space hours, 87.14 sample hours.

Professor Record, 1 post doctoral fellow, and 1 graduate student used the neutron activation analysis service in a study of sodium and rubidium interactions with DNA. Research is supported by NSF and NIH.

Professor Wright and 1 graduate student used the neutron activation analysis service to measure sodium and manganese levels in calcium fluoride crystals. Support unknown.

Professor Ellis and 1 graduate student used the neutron activation analysis service to measure the silver content in phosphate samples. Support unknown.

Dairy Science Department. (NAA) 4320 samples, 44 irradiations, 132 irradiation space hours, 12,966 sample hours.

Professor Jorgensen, 1 additional staff member, 4 graduate students and 2 undergraduates used the neutron activation analysis service for stable tracer measurements on particle reduction, rate of passage of undigested feed particles, and digestibility in cattle. Supported by state funds, federal (Hatch Act) and industrial gifts.

Professor Satter, 1 additional staff member, 1 post doctoral fellow, and 3 graduate students measured rare earth elements used as indigestible markers in cattle to follow the progress of digestion in the animals. Supported by federal (Hatch Act) and industrial gifts.

Engineering Experiment Station. (NAA) 3 samples, 1 irradiation space hour, 3 sample hours.

Two staff members used the facility to determine the composition of various solders. Supported by Wisconsin Electric Utilities Research Funds.

Globe Battery Division of Johnson Controls. (NAA) 351 samples, 287 less than 15 minutes, 50 irradiations, 12.74 irradiation space hours, 81 sample hours.

Measurement of impurity levels of lead samples to be used in batteries. Industrial support.

Medical Physics Department. 8 samples, 5 less than 15 minutes,, 12 irradiations, 29 irradiation space hours, 28.48 sample hours.

Professor Nickles, 2 additional staff members, 1 post doctoral fellow. Production of Argon-41 to measure partition coefficients for gas in blood for determining the clearance of Argon-41 in vivo following fast neutron activation. Supported by NIH.

Medicine Department. (NAA) 18 samples, 1 irradiation, 2 irradiation space hours, 36 sample hours.

One staff member used the neutron activation analysis service to determine impurity levels in solutions used to keep kidneys viable while awaiting transplant. Support unknown.

Meteorology Department. (NAA) 20 samples, 4 irradiations, 4 irradiation space hours, 18.1 sample hours.

Professor Wang, 1 graduate student used the neutron activation analysis service for determining the mass indium aerosol particles scavenged by snow. Supported by Environmental Protection Agency.

Michigan State University. (NAA) 394 samples, 4 irradiations, 12 irradiation space hours, 1,182 sample hours.

Professor Weber and 1 graduate student of the Department of Animal Science used rare earth stable tracers as markers in ruminant nutrition research involving rate of passage and extent of digestion of feed constituents. Supported by the Michigan Agricultural Experiment Station.

Nuclear Engineering Department

NE 427. 62 samples, 40 less than 15 minutes, 11 irradiations, 7.8 irradiation space hours, 42 sample hours. Irradiation of foils in support of laboratory instruction.

NE 428. 100 samples, 52 less than 15 minutes, 62 irradiations, 51.1 irradiation space hours, 116.31 sample hours. Irradiation of foils for laboratory instruction.

Reactor Laboratory and Utility Training. 49 samples, 26 less than 15 minutes, 32 irradiations, 17.57 irradiation space hours, 109.94 sample hours. Tests of neutron activation analysis techniques and preparation of samples used in calibration of reactor instrumentation.

Nuclear Medicine Department. 140 samples, 13 less than 15 minutes, 74 irradiations, 43.83 irradiation space hours, 89.16 sample hours.

Professor Gatley, 1 additional staff member, 4 students.

Production of fluorine-18 to produce compounds for positron emission tomography. Supported by National Cancer Institute, UW Medical School, and Graduate School.

Pharmacy Department. (NAA) 22 samples, 13 less than 15 minutes, 14 irradiations 2.08 irradiation space hours, 9 sample hours.

Professor Albrecht and 1 graduate student. Use of neutron activation analysis service to identify and quantify trace elements in mineral dust samples used for immuno-toxicology studies. Supported by NEIHS predoctoral training grant.

Physics Department. (NAA) 8 samples, 3 irradiations, 8.5 irradiation space hours, 13.5 sample hours.

Professor Knutson and 1 student. Determination of ytterbium concentrations in samples of yttrium ethyl sulfate. Analysis of samples for the presence of other contaminants and analysis of synthesized crystals. Supported by the Department of Energy.

Residual Materials Technology, Inc. (NAA) 45 samples, 22 less than 15 minutes, 23 irradiations, 3.83 irradiation space hours, 46 sample hours.

Neutron activation analysis service used to determine composition of fly ash samples. Supported by industrial funds.

Reactor Sharing Program.

Carroll College. 2 samples less than 15 minutes, 2 irradiations, .17 irradiation space hours. Activation for neutron activation analysis laboratory session.

South Dakota State University. (NAA) 37 samples, 18 less than 15 minutes, 21 irradiations, 10.5 irradiation space hours, 81 sample hours.

Professor Graetzer, 2 other staff members, and 1 graduate student of the Physics Department used the neutron

activation analysis service to determine trace elements in fish and plants growing in a sanitary landfill as possible indicators of heavy metals picked up in the ground water. Supported by the Office of Water Research and Reactor Sharing Program.

University of Wisconsin-Eau Claire. 5 samples less than 15 minutes, 3 irradiations, .25 irradiation space hours. Irradiations in support of neutron activation analysis session.

University of Wisconsin-Platteville. 5 samples, all less than 15 minutes irradiations, 5 irradiations, .42 irradiation space hours. Irradiations in support of neutron activation analysis laboratory session.

All of these instructional and research uses were supported by the United States Department of Energy's Reactor Sharing Program.

Safety Department. (NAA) 48 samples, all less than 15 minutes, 48 irradiations, 4 irradiation space hours.

Measurement of halogen content of organic waste samples. Supported by the University of Wisconsin.

Soils Department. 460 samples, 387 less than 15 minutes, 19 irradiations, 11.5 irradiation space hours, 146 sample hours.

Two staff members, 1 post doctoral fellow, 1 graduate student.

Development of rare earth tracer techniques to measure in-situ biogenic sediment redistribution by deposit feeding benthic microinvertebrates. Supported by the Environmental Protection Agency.

Tracer studies of elemental behavior in environmental systems. Supported by federal Hatch Act and EPA.

U.S. Department of Agriculture, Beltsville, Md., Animal Science Institute. (NAA) 183 samples, 21 less than 15 minutes, 27 irradiations, 10.25 irradiation space hours, 328 sample hours.

Dr. Glenn and one other staff member used stable tracer techniques to quantify dietary external markers in digesta and feces of ruminants. Supported by the U.S. Department of Agriculture.

University of Maryland. (NAA) 918 samples, 9 irradiatons, 27 irradiation space hours, 2,754 sample hours.

Professor Erdman of the Department of Animal Science and his graduate students used stable tracer techniques for measuring feedstuff utilization in cattle. Support unknown.

University of Minnesota. (NAA)

126 samples, 2 irradiations, 1 irradiation space hour, 63 sample hours.

Professor Donker and 1 graduate student used the neutron activation analysis service to measure turnover rates of liquids and solids in digestive tracts of ruminant animals and to measure the capacities of the gastro-intestinal tract of those animals. Research supported by the U.S. Department of Agriculture.

289 samples, 181 less than 15 minutes, 184 irradiations, 21.07 irradiation space hours, 216 sample hours.

Professor Gorham of the Department of Ecology and Behavioral Biology with 1 post doctoral and 1 graduate student is

using the neutron activation analysis service to analyze plants and peat cores from bogs ranging from Minnesota to Newfoundland. Research supported by the National Science Foundation.

University of Wisconsin Hospitals and Clinics. (NAA) 27 samples, 2 irradiations, 2 irradiation space hours, 27 sample hours.

Professor Everson used the neutron activation analysis service to analyze water samples for heavy metal contaminants. Support unknown.

Veterinary Science Department. 5 samples, 2 irradiations, 9 irradiation space hours, 24 sample hours.

Activation of asbestos fibers to allow detection and autoradiographs in animal tissue to determine the spread of aspirated asbestos in animals. Support unknown.

5. CHANGES IN PERSONNEL, FACILITY, AND PROCEDURES

Changes reportable under 10 CFR 50.59 are indicated in Section E of this report.

Licensed Senior Operator, Michael C. Jensen, completed his university degree requirements and accepted employment with a utility company. Licensed operator, John C., Mulvenna, left university employment in June, 1983. This leaves a licensed operations staff of three operators and four Senior Operators.

The audible portion of the evacuation alarm was replaced due to an upgrade of the building fire alarm system that resulted in a fire alarm signal similar to the evacuation alarm audible signal. The new audible alarm is a distinctive "Slow Whoop". The modification also provides a capability of paging and announcements over the alarm system should it be desirable.

6. RESULTS OF SURVEILLANCE TESTS

Surveillance tests and inspections during the year revealed no safety-related defects.

B. OPERATING STATISTICS AND FUEL EXPOSURE

Operating Period	Startups	Critical Hours	MW Hours	Pulses
FY 82-83	198	718.5	606.39	36
Total Present Core	883	3126.18	2371.38	181
Total TRIGA Cores	2938	10308.96	7511.16	1542

C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There were no shutdowns initiated for emergency reasons during the year. The building evacuation alarm was spuriously activated on 9/27/82 when building electrical power was lost and subsequently restored. There were 8 inadvertent scrams distributed as indicated below:

2 Trainee Operator Error Trips

2/22/83--Trainee failed to uprange picoammeter in a timely fashion.

2/25/83--Trainee made a control blade withdrawal before log-N meter was fully on-scale. When the meter came on-scale a period trip resulted.

2 Spurious Trips from Fuel Temperature Indicating Meter

2/10/83, 3/24/83--While operating at steady-state power level, fuel temperature meter 19MI initiated a trip without discernible upscale meter movement. This instrument incorporates an upscale burnout feature and is sensitive to noise spikes on the AC power service. In both cases, the signal leads were tightened. The meter was reading normally before and after each trip.

2 Period Trips

12/2/82, 3/14/83--Period trip received during a startup after a prestartup checkout which included checks of the pulsing control circuits. Pulse mode operation and checkout includes automatic disconnection of signal input from the log-N period amplifier, removal of the high voltage from the detector, and shorting of the detector signal output to ground with subsequent automatic restoration of these conditions to normal. This completely discharges the signal cable and, at shutdown, the cable requires a long time to complete charging back to the normal condition. A large upscale period meter deflection results, and the instrument trips. This problem does not occur during actual pulsing operation since detector current is large enough to eliminate this effect.

2 Noise Spikes Caused Trip Without Upscale Movement on Instrument

11/2/82--Picoammeter #1 trip -- no upscale movement on pa #1 or #2.

4/4/83--Scram with no instrument indication when mode switch was switched from manual to square wave position. It was not possible to get this behavior to repeat on subequent attempts to reproduce it.

D. MAINTENANCE

Routine preventative maintenance kept equipment in good operating condition. The thermal column door seal (weatherstripping) was replaced due to normal deterioration.

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

The pneumatic tube "receive only" station referenced in SAR Figure 22, page 2-40 and in the first two sentences of section 2.4.4 was removed on August 6, 1982. The switching terminal associated with this station was a recurrent source of air leaks, and it had not been used to receive samples in over five years. It is, however, possible that a need for the facility will occur in the future, so the removed equipment is being retained for possible future use.

F. RADIOACTIVE WASTE DISPOSAL

1. Solid Waste

No waste was transferred offsite during the year.

2. Liquid Waste

There were two liquid waste discharges during the year. The concentrations at discharge were below MPC levels without considering dilution by the sewage discharge flow. Table 1 details the discharges to the sewer system.

3. Particulate and Gaseous Activity Released to the Atmosphere

Table 2 presents information on stack discharges during the year.

TABLE 1

LIQUID WASTE TO SANITARY SEWER

	3 Sept 82	29 April 83	Annual Total
Total Activity Discharged (Microcuries)	126.26	227.83	354.09
Liquid Quantity Gallons	600	1200	1800
Co57 - MPC - 4E-4			
Microcuries	0.322	--	0.322
Microcuries/ml	1.42E-7	--	
Co58 - MPC - 4E-3			
Microcuries	8.15	13.13	21.28
Microcuries/ml	3.6E-6	2.9E-6	
Co60 - MPC - 1E-3			
Microcuries	6.06	26.2	32.26
Microcuries/ml	2.7E-6	5.7E-6	
Zn65 - MPC - 3E-3			
Microcuries	79.0	130.2	209.2
Microcuries/ml	3.5E-5	2.9E-5	
Mn54 - MPC - 4E-3			
Microcuries	19.0	58.3	77.3
Microcuries/ml	8.4E-6	1.3E-5	
Cr51 - MPC - 5E-2			
Microcuries	13.73	--	13.73
Microcuries/ml	6.06E-6	--	

All concentrations discharged were below MPC without accounting for dilution by sewage flow.

Average concentration at point of release to sewer = 5.2E-5 microcuries/ml. (Includes natural radioactivity)

Average daily sewage flow for dilution = 2.37E-4 gallons.

Average yearly concentration = 3.95E-7 microcuries/ml.

TABLE 2

EFFLUENT FROM STACK

1. Particulate Activity

There was no discharge of particulate activity in excess of background levels.

2. Gaseous Activity - All Argon 41

Month	Activity Discharged (Curies)	Maximum Instantaneous Concentration Microcuries/ml x E-6	Average Stack Concentration Microcuries/ml
July '82	.3501	3.6	19.1
August	.2585	8.0	14.9
September	.1881	1.5	10.9
October	.3030	1.9	17.3
November	.2737	1.3	15.9
December	.3845	4.0	18.4
January '83	.2600	3.0	17.4
February	.1129	1.0	7.0
March	.1326	1.0	7.4
April	.1465	1.1	8.18
May	.1263	1.2	7.19
June	.0913	0.9	5.32
TOTAL	2.6275	8x E-6 max	1.25E-7

The MPC used is that calculated in the SAR to be equivalent to 2.4x E-5 microcuries/ml.

The MPC above is that calculated in the SAR to be equivalent to 3x E-8 microcuries/ml in the area surrounding the laboratory.

The maximum instantaneous concentration released was 0.333 of MPC, while the average concentration released was 0.0052 of MPC.

G. SUMMARY OF RADIATION EXPOSURES (1 JULY 1982 - 30 JUNE 1982)

No excessive exposure of personnel to radiation occurred during the year. The highest exposure for any employee was 130 mrem whole body and 50 mrem skin which may be compared to the federally-permissible dose of 5,000 mrem per year. The highest annual dose for any student was 40 mrem whole body and 90 mrem skin.

Routine radiation and contamination surveys of the facility revealed no areas of high exposure rates or high contamination levels due to operation of the facility.

H. RESULTS OF ENVIRONMENTAL SURVEYS

The environmental monitoring program at Wisconsin consists of thermoluminescent dosimeters (LiF TLD service from Eberline) located in areas surrounding the reactor laboratory.

The table below lists doses for persons continuously in the area for representative dosimeter readings.

Annual Dose Data--Environmental Monitors

Location	Average Dose Rate-mrem/week
Inside Wall of Reactor Laboratory (Normal)	3.34 ± .20
Inside Wall of Reactor Laboratory (Beamport Open)	9.99 ± 1.47
Inside Reactor Laboratory Stack	.89 ± .38
Highest Dose Outside Reactor Laboratory (Reactor Lab roof entrance window: Monitor adjacent to stone surface)	1.95 ± .34
Highest Dose in Occupied Nonrestricted Area (third floor classroom facing away from Reactor Lab - Room 314)	.57 ± .04
Average Dose in Occupied Nonrestricted Area	.39 ± .11
Average Dose in All Unrestricted Areas (29 Monitor Points)	.52 ± .36

I. PUBLICATIONS AND PRESENTATIONS ON WORK BASED ON REACTOR USE

Biochemistry/Chemistry

Bleam, M.L., Anderson, D.F. and Record, M.T. Jr., "23Na NMR Studies of Cation-DNA Interactions," Biochemistry (1983). In press.

Three other publications submitted.

W. R. Braunlin, PhD thesis, "NMR Studies of Association of Small Ions with DNA." (1982).

D. K. Chang, "Polyelectrolytes: Thermodynamic and Spectroscopic Studies," in preparation. (1983).

Dairy Science

C. D. Lu, N. A. Jorgensen, A. L. Pope and R. J. Straub, "Digestion and Nutrient Flow in the Gastrointestinal Tract of Sheep Fed Alfalfa Protein Concentrate Prepared by Various Methods," Journal of Animal Science, Vol. 55, No. 3, pp 690 - 699. (1982).

Medical Physics

M. S. Rosenthal, P. M. DeLuca, D. W. Pearson, and R. J. Nickles, "Bone Blood Flow Measured by 41Ar Clearance Formed by Fast Neutron Activation," Medical Physics, 10. (1983).

Pharmacy

Peter S. Thorne, PhD thesis, due for completion in May 1984.

Soil Science

Jordan K. Lampert, PhD thesis, "Measurement of Trace Cation Activities by Donnan Membrane Equilibrium and Atomic Absorption Analysis", (1982).

Philip A. Helmke, "Neutron Activation Analysis in Methods of Soil Analysis", Part 2, "Chemical and Microbiological Properties', Eds. A. L. Page, R. H. Miller, and D. R. Keeney. Agronomy Monograph no. 9 (2nd Edition), pp 67-84, (1982).

South Dakota State University

James Dornbush, M.S. thesis in preparation.

University of Minnesota

Donker, J. D., and Munson, D. M., "A Comparison of Grass and Legume Hays Fed to Yearling Holstein Heifers, Journal of Dairy Science, 65, p. 154, (1982).

U. S. Department of Agriculture

Hammond, A. C., B. P. Glenn and G. B. Huntington, "Site of 3-Methylindole and Indole Absorption in Steers Following Ruminal Administration of L-Tryptophan," American Journal of Veterinary Research, (1983).

University of Wisconsin

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July 27, 1983

James R. Miller, Chief
Standardization and Special Projects Branch
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Enclosed herewith is a copy of the Annual Report for the University of Wisconsin Nuclear Reactor Laboratory as required by our Technical Specifications.

Very truly yours,

R. J. Cashwell
Reactor Director

RJC:mld

Enc. (Annual Report 82-83)

Copy: U. S. Nuclear Regulatory Commission
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