

ANNUAL OPERATING REPORT FOR LICENSE R-74
THE UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR
FISCAL YEAR 1983-1984

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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. Sixty-two 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 and spring semesters and had an enrollment of thirty. 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 seventeen, 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-eight 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:

Carleton College (Minnesota)--Professor Henrickson and 12 undergraduate students used the NAA service to analyze rocks, pottery, and sediments for senior theses projects.

Carroll College (Wisconsin)--Professor Auchter and 4 of his advanced chemistry students came to the laboratory for a 4-hour NAA laboratory session.

UW-Green Bay--Professor Norman and 7 students in Nuclear Physics and Radiochemistry visited the laboratory for a 4-hour laboratory session on neutron activation analysis.

Edgewood College (Wisconsin)--Professor Swanson and 8 students attended a neutron activation analysis laboratory session.

Nebraska Wesleyan University--Professor Goss and 1 graduate student used the NAA service to examine two meteorites for common origin.

Lakeshore Technical Institute (Wisconsin)--Professor Reindel and 17 of his students in a Health Physics Technician Training Program visited the laboratory for a reactor operating characteristics demonstration and familiarization with instruments used to detect radioactive effluents.

University of Minnesota-Duluth--Professor Rapp and his research group continued their work using NAA of artifacts to determine provenance of metals and pottery.

3. UTILITY PERSONNEL TRAINING

Two groups (15 trainees) of STA candidates from Wisconsin Public Service Corporation attended our two-week Research Reactor Training Program. This program gives operating practice while it reinforces previous 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 4,048 samples (2081 separate irradiations) irradiated during the year. There were 2,290 samples which received short (15 minutes or less) irradiations. Other samples accumulated 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.

A. D. Little, Inc. (NAA) 136 samples, 79 less than 15 minutes, 84 irradiations, 16.9 irradiation space hours, 119.61 sample hours

Measurement of elemental concentrations in fly ash samples for pollution studies. Supported by industrial funds.

Center for Great Lakes Studies-UW-Milwaukee. (NAA) 1078 samples, 1042 less than 15 minutes, 1043 irradiations, 89.8 irradiation space hours, 108 sample hours.

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

Chemistry Department. (NAA) 68 samples, 60 less than 15 minutes, 37 irradiations, 5.5 irradiation space hours, 4 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.

Dairy Science Department. (NAA) 238 samples, 3 irradiations, 9 irradiation space hours, 714 sample hours.

Professor Jorgenson, 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.

Enzyme Institute (University of Wisconsin-Madison). (NAA) 13 samples, 8 less than 15 minutes, 9 irradiations, 2.67 irradiation space hours, 10 sample hours.

Prof. Landy, 1 postdoctoral fellow, and 1 graduate student measured amount of selenium in an enzyme and attempted to determine whether any metals were present in a substance that stimulates an enzyme reaction. Supported by NIH.

Globe Battery Division of Johnson Controls. (NAA) 230 samples, 230 less than 15 minutes, 137 irradiations, 12.08 irradiation space hours.

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

Institute for Environmental Studies (University of Wisconsin-Madison). (NAA) 5 samples all less than 15 minute irradiation, 5 irradiations, 0.42 irradiation space hours.

Prof. DeWitt and 1 graduate student attempted to measure trace element concentrations (primarily Selenium) in peat. Support unknown.

University of Illinois. (NAA) 74 samples, 1 irradiation, 3 irradiation space hours, 222 sample hours.

Prof. A. H. Jensen and 1 graduate student determined Ytterbium marker concentrations in sow feces to estimate digesta transit time through the hindgut. Support unknown.

Medicine Department. (NAA) 36 samples, 18 less than 15 minute irradiation, 19 irradiations, 3.5 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 by NIH.

Meteorology Department. (NAA) 67 samples, 58 less than 15 minute irradiation, 52 irradiations, 5.7 irradiation space hours, 2.52 sample hours.

Professor Wang, 1 graduate student used the neutron activation analysis service for determining the mass of 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 and NE 428 instructional use. 238 samples, 84 less than 15 minutes, 77 irradiations, 60.7 irradiation space hours, 206.83 sample hours. Irradiation of foils in support of laboratory instruction.

Reactor Laboratory and Utility Training. 34 samples, 22 less than 15 minutes, 23 irradiations, 4.11 irradiation space hours, 20.07 sample hours. Tests of neutron activation analysis techniques and preparation of samples used in calibration of reactor instrumentation.

Nuclear Medicine Department. 62 samples, 2 less than 15 minutes, 33 irradiations, 23.17 irradiation space hours, 42.95 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.

Physics Department. (NAA) 30 samples, 3 irradiations, 1.5 irradiation space hours, 15 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.

Reactor Sharing Program.

Carroll College. 6 samples less than 15 minutes, 6 irradiations, .5 irradiation space hours. Activation for neutron activation analysis laboratory session.

Carleton College (NAA) 139 samples, 5 irradiations, 10 irradiation space hours, 288 sample hours. Prof. E. Henrickson of the Geology department had 6 groups of 2 undergraduate students use the NAA service for senior theses on geological problems.

Edgewood College. (NAA) 2 samples, 2 less than 15 minutes, 2 irradiations, 0.42 irradiation space hours.

Samples irradiated for NAA laboratory exercise.

University of Minnesota-Duluth. (NAA) 72 samples, 2 irradiations, 4 irradiation space hours, 144 sample hours.

Prof. Rapp, 2 staff members, and 2 students continued work on determining common origin of copper and pottery artifacts.

University of Wisconsin-Green Bay. 18 samples, 9 less than 15 minutes, 10 irradiations, 1.75 irradiation space hours, 9 sample hours. Irradiations in support of neutron activation analysis session.

Nebraska Wesleyan University. (NAA) 13 samples, 7 less than 15 minutes, 8 irradiations, 2.59 irradiation space hours, 12 sample hours.

NAA of meteorite sampler to determine common origin. Unsupported research.

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

Safety Department. (NAA) 10 samples, all less than 15 minutes, 10 irradiations, 0.83 irradiation space hours.

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

Safety Engineering Associates. (NAA) 20 samples, 10 less than 15 minutes, 12 irradiations, 2.83 irradiation space hours, 10 sample hours.

Determination of whether two paint samples matched in trace element composition. Industrial support.

Soils Department. 42 samples, all less than 15 minutes, 3 irradiations, 0.67 irradiation space 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) 144 samples, 4 irradiations, 8 irradiation space hours, 288 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) 204 samples, 2 irradiations, 6 irradiation space hours, 612 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) 994 samples, 526 less than 15 minutes, 529 irradiations, 68.98 irradiation space hours, 936 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) 9 samples, 4 less than 15 minutes, 5 irradiations, 2.33 irradiation space hours, 10 sample hours.

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

Warzyn Engineering, Inc. (NAA) 42 samples, all less than 15 minutes, 7 irradiations, 1.75 irradiation space hours.

Determination of halogen content of groundwater. Industrial support.

Zoology Department. (NAA) 24 samples, all less than 15 minutes, 24 irradiations, 2 irradiation space hours.

Graduate student used NAA to detect low levels of toxic elements in aquatic insects. Unsupported preliminary program.

5. CHANGES IN PERSONNEL, FACILITY, AND PROCEDURES

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

Licensed operator, Jeffrey Franzen, completed his degree requirements and left for other employment during the year. Five individuals are currently enrolled in an operator training program.

As part of an attempt to reduce the number of spurious reactor scrams a modification of 19M1, the fuel temperature indicator, was performed. The instrument is a LFE Compak IV, Mark I Controller. Communication with the manufacturer indicated that other users of this device had experienced similar spurious operation due to sensitivity to power line noise and RF pickup from nearby sources, including security force radio operation. The manufacturer suggested a replacement meter which did not have the problem (due to a slower response time). It was also noted that the currently manufactured units of the meter (Compak IV, Mark II) had additional filtering of comparator inputs. The RSC approved

modification of the installed devices to match the Mark II circuits and replacement of the device with the unit suggested by the manufacturer should the modification not prove acceptable. The modifications were made, and a considerable reduction in number of spurious scrams was observed. Further operating experience with the modified instruments is desired before a final decision on replacement of the unit is made.

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 83-84	176	694.20	550.10	49
Total Present Core	1059	3820.38	2921.48	221
Total TRIGA Cores	3114	11003.16	8061.26	1582

C. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS

There were no shutdowns initiated for emergency reasons during the year. There were 18 inadvertent scrams distributed as indicated below:

8 Trainee Operator Error Scrams

- 2/10/84--Trainee failed to uprange #2 pA in a timely fashion.
- 2/10/84--Trainee downranged #1 pA while at too high a reading.
- 2/10/84--Trainee failed to uprange #2 pA in a timely fashion.
- 2/13/84--Trainee failed to uprange #2 pA in a timely fashion.
- 2/16/84--Trainee turned #2 pA range in wrong direction.
- 2/24/84--Trainee dropped transient control rod by pressing "air" button when intending to press "out" button in order to withdraw transient rod.
- 2/24/84--Trainee turned #1 range switch in wrong direction.
- 6/6/84--Trainee turned #2 pA range switch in wrong direction.

2 Spurious Scrams Attributed to Fuel Temperature Indicating Meter 19M1

- 8/23/83--Relay scram apparently coincident with failure of high voltage relay (part of a plasma physics experiment in an adjacent laboratory.) No upscale deflection of fuel temperature meters noted, and no power level or period indications indicating

any power level changes before the scram.

9/13/83--Relay scram with no indication of any change on any instrument.

10/4/83--Relay scram with no indication of any change on any instrument.

10/13/83--Relay scram, with momentary noisy upscale fuel temperature meter deflection, which is typical of previous upscale-burnout behavior of a fuel thermocouple. Temperature indication was normal following the scram, and connections and thermocouple resistances remained normal.

10/21/83--Relay scram with no upscale deflection noted on any instrument. The thermocouple connected to the fuel temperature meter (41T) was replaced with a spare in the same instrumented element (41C). Thermocouple 41T was still intact at the end of the report period, however.

11/3/83--Relay scram from fuel temperature meter, with indication of intermittent open thermocouple indication.

11/11/83--Relay scram from fuel temperature meter, with indication of intermittent open thermocouple indication.

Note: See Section A5 for a description of corrective actions performed during the annual maintenance shutdown.

2/28/84--Relay scram concurrent with switching control element manual rundown switch to rundown position. No instrument response observed to indicate origin of scram and would not repeat response.

3/20/84--Relay scram concurrent with control blade raise/lower switch operation. No instrument response observed, although two operators were observing console at the time of occurrence.

These last two scrams are included under fuel temperature scrams even though it is not known that the fuel temperature scram was involved, since previous non-annunciated scrams seem to have originated in this channel. It should be noted that the frequency of such scrams decreased greatly since the instrument was modified.

1 Scram Due To Loss of AC Power Source

5/29/84--Relay scram upon complete loss of AC power to the building due to external distribution problem.

D. MAINTENANCE

Normal preventive maintenance kept equipment in good operating condition. See Section A.5 for modifications and Section E for any changes reportable under 10 CFR 50.59.

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

Figures on pages 2-39 and 3-36 of the Safety Analysis Report indicate filters used in ventilation systems by manufacturer and model number. The model numbers indicated are not those

presently used by the manufacturer, but the filters presently used meet or exceed the specifications of the indicated filter combinations.

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

Date of discharge	16 Nov 83	31 May 84	Annual Total
Total Activity Discharged (Microcuries)	210.40	98.67	309.07
Liquid Quantity Gallons	1550	1425	2975
Co-58 - MPC - 4E-3 Microcuries Microcuries/ml	2.38 4.04E-7	6.20 --	8.58
Co-60 - MPC - 1E-3 Microcuries Microcuries/ml	1.86 2.49E-7	7.16 1.33E-6	9.02
Zn-65 - MPC - 3E-3 Microcuries Microcuries/ml	74.99 1.28E-5	61.51 1.14E-6	136.50
Mn-54 - MPC - 4E-3 Microcuries Microcuries/ml	3.02 5.16E-7	13.47 2.50E-6	16.49
Cr-51 - MPC - 5E-2 Microcuries Microcuries/ml	26.77 4.57E-6	10.30 1.92E-6	37.07
Fe-55 - MPC - 2E-2 Microcuries Microcuries/ml	98.07 1.45E-5	-- --	98.07
Fe-59 - MPC - 2E-3 Microcuries Microcuries/ml	1.82 2.68E-7	-- --	1.82
Ra-226 - MPC - 4E-7 Microcuries Microcuries/ml	1.50 2.56E-7	-- --	1.50

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

Average concentration at point of release to sewer = 2.75E-5 microcuries/ml. (Includes natural radioactivity)
Average daily sewage flow for dilution = 2.37E4 gallons.
Average yearly concentration = 9.4E-9 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 $\times 10^{-6}$)	Average Stack Concentration
July '83	.0578	1.0	.0322
August	.1012	1.1	.0565
September	.1269	1.1	.0729
October	.1415	0.9	.0789
November	.1445	1.1	.0829
December	.1084	1.1	.0570
January '84	.1662	1.5	.0990
February	.0996	0.8	.0595
March	.1913	2.0	.1030
April	.2402	5.0	.1430
May	.2187	1.8	.1220
June	.1562	1.3	.0873
TOTAL	1.7525	5.0 (maximum)	.0830

The MPC used is 2.4×10^{-5} microcuries/ml. This MPC is that calculated in the SAR to result in a concentration of 3×10^{-8} microcuries/ml in the area surrounding the laboratory.

The maximum instantaneous concentration released was 0.208 of MPC, while the average concentration released was 0.0034 of MPC.

G. SUMMARY OF RADIATION EXPOSURES (1 JULY 1983 - 30 JUNE 1984)

No excessive exposure of personnel to radiation occurred during the year. The highest exposure for any employee was 120 mrem whole body and 120 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 40 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	5.0 ± 1.43
Inside Reactor Laboratory Stack	1.72 ± 0.11
Highest Dose Outside Reactor Laboratory (Reactor Lab roof entrance window; Monitor adjacent to stone surface)	2.84 ± 0.51
Highest Dose in Occupied Nonrestricted Area (third floor classroom facing away from Reactor Lab - Room 314)	1.47 ± 0.05
Average Dose in Occupied Nonrestricted Area	1.30 ± 0.10
Average Dose in All Unrestricted Areas (29 Monitor Points)	1.40 ± 0.32

I. PUBLICATIONS AND PRESENTATIONS ON WORK
BASED ON REACTOR USE

Nuclear Engineering Department

K. R. Okula, W. F. Vogelsang, "Aspects of Tritium Release from Neutron-Irradiated Lithium Oxide," presented as a poster session paper at the Third Topical Meeting on Fusion Reactor Materials, Albuquerque, New Mexico, September 19-22, 1983.

Physics Department

One publication and one PhD thesis about the polarized target are presently being written.

Soils Department

Paul R. Anamosa, M.S. thesis, "Comparison of calculated and measured free cation activities of Cd and Zn in synthetic solutions and soil extracts," University of Wisconsin (1984).

Ronald T. Checkai, PhD thesis, "Cadmium uptake by plants from a mixed resin hydroponic system," University of Wisconsin (1984).

University of Illinois at Urbana, Animal Science Department, David P. Holzgraefe, PhD thesis, "Influence of dietary alfalfa, orchard grass, hay and lasalocid on sow reproductive performance," University of Illinois at Urbana (1984).

University of Minnesota-Duluth

George Rapp, Jr., James Allert and Eiler Henrickson, "Trace Element Discrimination of Discrete Sources of Native Copper," American Chemical Society, Washington, D. C. (1984).

George Rapp, Jr., "Native Copper and the Beginning of Smelting: Chemical Studies," sponsored by the Pierides Foundation in collaboration with the Department of Antiquities, Republic of Cyprus, June 1-6, (1981).

University of Wisconsin

NUCLEAR REACTOR LABORATORY
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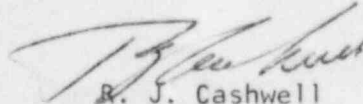
July 19, 1984

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 83-84)

Copy: U. S. Nuclear Regulatory Commission
Region III
Office of Inspection and Enforcement
Glen Ellyn, IL 60137

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