Progress Report
1987-88
University of Missouri-Rolla
Nuclear Reactor Facility

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PROGRESS REPORT

FOR THE

UNIVERSITY OF MISSOURI-ROLLA

NUCLEAR REACTOR FACILITY

APRIL 1, 1987 to MARCH 31, 1988

Submitted to

The U.S. Nuclear Regulatory Commission

and

The University of Missouri-Rolla

Albert E. Bolon, Director

Milan Straka, Manager

Nuclear Reactor Facility

University of Missouri-Rolla

Rolla, Missouri

65401

Summary

During the 1987-88 reporting period the University of Missouri-Rolla Reactor was in operation for 763 hours. The major part of this time, 52%, was used for class instruction and training purposes. About 43% of the reactor time was used for research and irradiation service and 5% was needed for maintenance runs.

There were 30 undergraduate and graduate students enrolled for course work at the reactor. This committed the facility to 52 student-hours of classes. The reactor was visited by about 2000 visitors during the past year. There were 400 participants in the Reactor Sharing Program this year involved in various reactor projects. The facility was reimbursed for this program from a grant awarded by the U.S. Department of Energy.

The reactor produced about 26 MW hours of energy using 1.3 g of uranium. A total of 301 samples have been irradiated at the reactor with most of them being analyzed in the Reactor Counting Laboratory.

Three one-week training programs for reactor operator trainees of a midwest utility were conducted during this reporting period. The reimbursement helped to defray facility costs and also helped to improve research and instructional capabilities.

A fast gamma-spectroscopy system has been purchased to enhance the research area focused on trace element analysis. Irradiation of samples prepared for studies on cancer tumors continued through this reporting period. A safety study, funded by the U.S. Department of Energy is being prepared for the mandated conversion of the UMR Reactor to low enriched uranium fuel. Its preliminary results were presented at the International Meeting on Reduced Enrichment for Research and Test Reactors, November 1987 held in Buenos Aires, Argentina, and the

American Nuclear Society Meeting, September 1987, held in Los Angeles, California.

The Weldon Springs Project involving the measurement of the efficiency of man-made aerosol scavengers nears completion. Neutron activation analysis has been used to measure the amount of deposited aerosol. The results are good and will be communicated in a pertinent technical journal. Presently, the results of this project are being used to support another proposal for studying enhanced removal of airborne fission products.

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I. Introduction

This progress report is prepared in accordance with the requirements of the Nuclear Regulatory Commission 10 CFR 50.71 concerning the operation of the University of Missouri-Rolla Nuclear Reactor Facility (License R-79).

The reactor, a swimming pool type, is operated as a university facility available to the faculty and students of the various departments of the university for their educational and research programs. Several other universities and colleges have made use of the facility during this reporting period. The facility is also made available for the purpose of training reactor personnel for the nuclear industry and electric utilities. Trace element analysis using neutron activation is also provided at the facility.

The reactor staff has continued to review the operation of the Reactor Facility in an effort to improve the safety and efficiency of its operation and to provide conditions conducive to its utilization by students and faculty from this and other universities. The following sections of this report are intended to provide a brief description of the various aspects of the operation of this facility, including its utilization for education and research.

II. Reactor Staff and Personnel

A. Reactor Staff

Name	Title
Albert E. Bolon	Director
Milan Straka	Reactor Manager
Carl Barton	Senior Electronic Technician
Juls Williams	Lab Mechanic
Francis Jones	Reactor Maintenance Engineer
Linda Pierce	Senior Secretary

B. Licensed Operators

Name	License
Albert E. Bolon	Senior Operator
Carl Barton	Senior Operator
Milan Straka	Senior Operator
Francis Jones	Senior Operator
Don Buth[1)]	Reactor Operator

1) terminated effective July 1, 1987

C. Radiation Safety Committee

Name	Department
Dr. Nord L. Gale (chairman)	Life Sciences
Mr. Ray Bono (secretary, ex officio)	Environmental Health and Risk Management
Dr. Ernst Bolter	Geology and Geophysics
Dr. Oliver K. Manuel	Chemistry
Dr. Albert E. Bolon	Reactor Director
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Dr. Edward Hale	Physics
Dr. Milan Straka (ex officio, non-voting)	Reactor Manager
Dr. Arvind Kumar	Nuclear Engineering

This committee is required to meet at three month intervals. However, in practice the frequency of the meetings is usually greater.

D. Health Physics

Name	Title
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Mr. Ray Bono	Director, Environmental Health & Risk Management
Mr. William Heineken	Health Physics Technician

III. Improvements

A continuous effort to enhance availability and reliability of the facility is being undertaken by the reactor staff. During this reporting period the following improvements have been made:

1) A new multi-channel analyzer and computer together with gamma-spectroscopy software were purchased to enhance our research efforts.
2) A DOS card was purchased and installed in the office AT&T computer to increase its capabilities.
3) Safety clothing (over-alls, boots, coat and gloves) were purchased for use in handling chemicals during the resin regeneration process.
4) A semiconducter curve tracer was purchased for use in demonstrating radiation effects on solid state electronics.
5) A new intrinsic germanium (Ge) detector has been purchased for use in the research laboratory.

IV. Reactor Operations

A. Facility Use

Table 1 depicts the current core loading which is designated as core 67. The number 67 denotes the sixty-seventh core configuration (assembly and location), that has been used at the Reactor Facility since the original operating license was issued in 1961. This core 67 has been in use since December of 1978. Its parameters are listed in Table 8 (Core Data).

Tables 2 through 7 give pertinent information about the Reactor Facility and its operation during the reporting period.

Table 1. UMRR Core Configuration and Rack Storage Form

DATE 31 March, 1986 LOADING NUMBER 67T or 67W*

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
									HF-1		F-13	F-20	F-22	

RACK STORAGE FACILITY

R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
										F-2	F-5	F-3	F-18	F-21

	1	2	3	4	5	6	7	8	9
A									
B					S				
C			HR-1	F-14	F-1	C-4			
D			F-8	C-1	F-16	F-9	F-4	F-10	
E			F-6	C-2	F-19	C-3	F-12	F-11	
F			BRT	F-17	F-15	F-7	CRT		

BRIDGE SIDE UMRR CORE STATUS

KEY TO PREFIXES

F - Standard Elements
C - Control Elements
HF - Half Front Element
HR - Half Rear Element
S - Source Holder

Other BRT - Bare Rabbit Tube
CRT - Cadmium Rabbit Tube

*T designates the thermal column-reflected mode, and W designates the water-reflected mode.

Table 2.

FACILITY USE OTHER THAN THE REACTOR

Facility		Hours
Bare Rabbit Tube		66.65
Beam Port		27.87
Reactor Console		499.83
	Total	594.35

Table 3.

REACTOR UTILIZATION

Reactor use	762.65 hr
Research and irradiation runs	330 hr
Instruction runs	289 hr
Maintenance runs	33.17 hr
Training	110.48 hr
Time at power	402 hr
Heat generated	25824 kw-hr
Total number of samples	301
Sample hours	158.61 hr
Research and instruction usage[1]	29.75 %
U-235 burned	1.11 g
U-235 burned and converted	1.33 g

[1] Based on 2080 working hours per year.

Table 4

RUNDOWNS

Date	Cause
04/16/87	(120% demand) Occurred when switching scales. Operator cautioned.
04/16/87	(120% demand) Occurred when switching scales. Operator cautioned.
05/01/87	(120% demand) Occurred when switching scales. Operator cautioned.
05/19/87	(120% demand) Occurred when switching scales. Operator cautioned.
07/29/87	(HIRAD) Repaired radiation monitor at demineralizer.
09/01/87	(120% rundown) Occurred when switching scales. Operator cautioned.
09/23/87	(120% demand) Occurred when switching scales. Operator cautioned.
10/18/87	(15 Sec.) Operator error. While 30 sec. bypass, functioning operator cautioned.
10/18/87	(120% demand) Occurred when switching scales. Operator cautioned
01/25/88	(120% demand) Occurred when switching scales. Operator cautioned.
01/29/88	(120% demand) Occurred while switching scales. Operator cautioned.
02/05/88	(120% demand) Occurred while switching scales. Operator cautioned.
02/09/88	(120% demand) Occurred when changing scales. Operator cautioned.
03/11/88	(Regulating Rod Insert Limit on Auto) Bad limit switch. Switch changed.

Table 5

SCRAMS

Date	Cause
04/22/87	(150% full power) Noise in safety channel. Safety channel checked.
04/23/87	(150% full power) Noise in safety channel. Safety channel checked. Removed and checked Log N CIC.
05/19/88	(Manual Scram) Training.
05/20/88	(Manual Scram) Training.
09/16/87	(150% Full Power) Checked safety channel and Log N CIC.
03/22/88	(150% Full Power) Placing magnet current switch in wrong position during log taking. Operator cautioned.

Table 6

MAINTENANCE
(Other than associated with
Rundown, Scrams, and Semi-Annuals)

Date	Cause
04/10/87	Auto Controller Will not operate at high power. Changed V_1, V_2, V_3 in Recorder.
04/22/87	Log N & Period Amplifier Spikes causing SCRAMS. Replaced CIC.
04/29/87	Log N Channel Log N Amplifier and Recorder reading low. Adjusted Log N CIC to Linear Channel.
05/28/87	Linear Channel Auto controller would not stay in auto. Adjusted setpoints.
07/20/87	Magnet No. 1 Magnet will not pick up rod. Repaired magnet.
08/06/87	Reg. Rod Switch Switch will not return to normal(neutral position). Rebuilt switch.
08/14/87	Shim Rod Switch Switch not returning to normal (Neutral position). Rebuilt switch.
08/14/87	Linear Recorder Recorder not tracking meter. Adjusted set point and clutch.
09/16/87	Auto Controller Causes rods to run in when placed in auto position. Replaced V_1, and V_2 in auto controller, also V_1 in recorder.
09/17/87	Log N Recorder Recorder indicating low. Adjusted recorder current using current source.

09/24/87	Log N Recorder Recorder indicating low. Adjusted recorder current using current source, after replacing R-11.
10/26/87	Area Monitor Local meter reading low. Cleaned adjustment potentiometers and reset.
11/04/87	Linear Recorder Auto controller will not hold. Adjusted cam and cam clutch and set point.
12/02/87	Magnet No. 1 Magnet coil has high resistance. Repaired magnet.
01/18/88	Resistivity Meter Resistivity meter reading low. Replaced resistivity probe.
03/11/88	Reg. Rod Insert Limit Light Light intermittent. Replaced micro switch.
03/28/88	Magnet Current Supply Current couldn't be adjusted to zero. Replaced V_3.
03/29/88	Safety Amp Chamber 1 power light on. Replaced V_8, V_{12}, V_{11}, R46.

Table 7.

CORE LOADING AND UNLOADING

Date	
6/29/87	Unload (67W to subcrit) for control rod inspection.
7/09/87	Reload (subcrit to 67W) to return to previous configuration.

B. Core Data

During this reporting period only the core designation 67 has been used. The "W" mode core (that is -- with the core completely reflected by water) was used for normal reactor operations. The "T" mode (with the core positioned near the graphite thermal column) is used for extended operation (>3 hrs), or beam port and thermal column experiments. The excess reactivity was measured for cold, clean critical conditions. In day-to-day operation the excess reactivity is quite often lower due to the temperature increase of the pool.

Table 8. CORE TECHNICAL DATA

Average Thermal Flux	1.6×10^{12} n/cm^2-sec at 200 kW
Maximum Thermal Flux	2.8×10^{12} n/cm^2-sec at 200 kW
Average Epithermal Flux	1.6×10^{11} n/cm^2-sec at 200 kW
Worth of Thermal Column	0.46%
Worth of Beam Port	not detectable

Rod Worth (in "T" mode)

Date	4-16-79	4-16-79	4-16-79	4-28-88
	I 2.64%	II 2.65%	III 3.36%	Reg. 0.354%

Excess Reactivity (in "T" mode) 0.73% Shutdown Margin (in "T" mode)*) 4.56%.

Reactivity Addition Rate (max % K/K/sec)

I 0.019	II 0.019	III 0.026	Reg. 0.01

Rod Drop Time (24")

I 410 msec.	II 400 msec.	III 430 msec.	Date 1-12-88

*) Rod No. III and Reg Rod not taken into account.

V. Public Relations

The reactor staff continues to help educate the public about the application of nuclear energy. Over 1887 persons toured the facility during this report period. Tour groups are usually given a brief orientation by a member of the reactor staff. Table 9 lists some of the public occasions and tours.

Some of the groups spent an entire day at the facility becoming acquainted with the reactor and performing simple experiments. Usually these groups are from colleges which have no reactor facilities. Many high schools (juniors and seniors) are given similar tours, too.

Table 9. PUBLIC RELATIONS PROGRAM

DATE	PARTICIPANT	NUMBER
April 8, 1987	Senior Citizen Tour, Illinois	33
April 25, 1987	Spring Open House	121
July 17, 1987	Summer Open House	50
October 22, 1987	Military Wives, Ft. Wood	22
October 24, 1987	Parents' Day	106
October 26, 1987	Material for Nuclear Applications Conference	13
October 31, 1987	University Day	202
February 20, 1988	Merit Badge University	30
February 23, 1988	Chemistry Short Course	15
February 27, 1988	Math Counts	9
March 10, 1988	Cub Scout Troop #246, Rolla	13
		614

VI. Education Utilization

Thirty UMR students, graduates and undergraduates, have participated in classes at the facility, utilizing 52 student-semester hours of allocated time. Also students from several colleges, and high schools have used the facility.

The following is a list of scheduled classes at the facility along with the total hours of reactor use for this reporting period.

Course	Title	Students	Reactor Hours
NE 300	Special Problems	2	15
NE 304	Reactor Laboratory I	8	48
NE 306	Reactor Operations	10	146
NE 308	Reactor Laboratory II	6	52
NE 490	Research	4	60

A program called Reactor Sharing Program, funded by the Department of Energy, was established for colleges and universities which do not own a nuclear reactor. In addition, high schools can participate in this program, too. About 400 students and their instructors participated in this program. Table 10 lists those schools or similar groups that were involved in this year's program.

Table 10. REACTOR SHARING PROGRAM

DATE	PARTICIPANT	NUMBER
April 16, 1987	St. Charles-West High School	22
May 7, 1987	Crocker High School	23
May 28, 1987	Sullivan High School	8
June 10, 1987	School of Engineering High Schools	61
June 11, 1987	Jackling Institute	41
June 25, 1987	Jackling Institute	36
August 13, 1987	Fundamentals of Engineering	96
September 28, 1987	Rolla Vo-Tech School	14
December 8, 1987	Nuclear Engineering Sophomores	8
January 6, 1988	Arkansas College	8
January 27, 1988	Washington High School	18
February 19, 1988	St. Francis Borgia High School	17
February 23, 1988	Potosi High School	11
February 25, 1988	University of Missouri-Columbia Nuclear Engineering	7
February 1988	Stephen Ingracia, West Plains High School, Individual	2
February 1988	Bob Salk, Rolla High School, Individual Project	1
March 10, 1988	Linn Technical College	27
		400

VII. Reactor Health Physics Activities

The health physics activities at the UMR Reactor Facility consist primarily of radiation and contamination surveys, monitoring of personnel exposures, airborne activity, pool water activity and waste disposal. Releases of all by-product material to authorized, licensed recipients are surveyed and recorded. In addition, health physics activities include calibrations of portable and stationary radiation detection instruments, personnel training, special surveys and monitoring of non-routine procedures. New Health Physics SOP's are being reviewed and additional SOPs are being written and will be implemented.

<u>Routine Surveys</u>

Monthly radiation surveys of the facility consist of direct gamma and neutron measurements with the reactor at power. No unusual exposure rates were found. Monthly surface contamination surveys consist of 20 to 30 swipes counted separately for alpha, beta and gamma activity. In 12 monthly surveys, no significant contamination outside of contained work areas was found.

<u>By-Product Material Release Surveys</u>

During the period, there were no shipments of by-product material released from the reactor facility with the exception of 12 RaD+E check sources and 1 Ra-226 source which were disposed of through an approved facility.

Routine Monitoring

Thirty reactor facility personnel and students frequently involved with operations in the reactor facility are currently assigned beta-gamma, neutron film badges which are read twice each month. There are 4 beta-gamma, neutron badges assigned and one test badge to check accuracy of exposure reports. Twenty-five campus personnel and students are assigned beta-gamma film badges, and frequently TLD ring badges for materials and X-ray work on campus. There are 28 spare badges assigned on campus. In addition, 4-7 direct-reading dosimeters are used for visitors and high radiation area work. There have been no personnel over exposures during the period.

Airborne activity in the reactor facility is constantly monitored by a fixed-filter, particulate continuous air monitor (CAM) located in the reactor bay. Argon-41 is routinely detected during operations.

Pool water activity is monitored monthly to ensure that no gross pool contamination nor fuel cladding rupture has occurred. Gross counts and spectra of long-lived gamma activity are compared to previous monthly counts. From April through March sample concentrations averaged 2.03×10^{-6} uCi/ml.

Waste Disposal

Release of gaseous and particulate activity through the building exhausts is determined by relating the operating times of the exhaust fans and reactor power during fan operation to previously measured air activity at maximum reactor power. During this period 404.03 millicuries were released into the air. Released isotope was identified as Ar-41.

Solid waste, including used water filters, used resins and contaminated paper is stored and/or transferred to the campus waste storage area for later shipment to a commercial burial site. Radioactive waste released to the sanitary sewer is primarily from regeneration of the resin exchange column. During this period 14 releases to the sanitary sewer totaling approximately 6310 gallons of concentrated resin regeneration solution and pool water were discharged with a total gross activity of 0.332 millicuries. One sample contained trace amounts of Cs-137. The total release for CS-137 was 5.91 microcuries in 465 gallon.

Instrument Calibrations

During this period, portable instruments were calibrated two times. Remote area monitors were checked for calibration two times.

VIII. Plans

The past efforts to upgrade research capabilities and to increase usage of the facility will continue in the future. It is intended to establish a group of regular users for the new fast gamma-spectroscopy system. This system which is equipped with a software for the peak search and nuclide identification enables a higher sample throughput and more accurate elemental analysis than in the past.

A study will be performed to assess the feasibility of a modification of the present pneumatic sample transfer system. The system would be modified such that some of the irradiated samples could be transferred directly from the reactor to the new system for analysis. This would eliminate manual sample handling and enable to analyze short-lived radioisotopes. Preliminary estimates show that about $20,000 will be needed for this upgrade.

A possibility to increase the reactor power, while still maintaining the cooling by natural convection, is being discussed. For that purpose a proposal to obtain external funds for a reactor power upgrade study will be prepared. It is hoped that such an upgrade would help to attract some of the users seeking higher neutron output.

Likewise, we will continue our effort to extend the group of utility users who use the facility for their reactor operator training. The reactor is an excellent teaching and training tool especially in the area of neutron and reactor physics. The reimbursement for the training will help to defray some of the facility costs and to purchase some needed research and instructional equipment.

The amount of research and development work could significantly be increased if the facility had a full time dedicated person for such work. It is planned, therefore, to arrange for a one-year (or longer) visit of a scientist who would work in the area of neutron activation analysis and perhaps would help to develop the neutron depth profiling technique. Thi. novel technique enables to measure the distribution of certain coating materials, e.g. the thickness of nitride and boron film layers. Different possibilities to find a funding for such a visit will be explored.

UNIVERSITY OF MISSOURI-ROLLA

Nuclear Reactor Facility

Nuclear Reactor
Rolla, Missouri 65401-0249
Telephone (314) 341-4236

May 20, 1988

Mr. Alexander Adams
Standardization & Special Projects
Division of Licensing - NRC
Washington D.C. 20555
Mail Stop 11-A-20

Dear Mr. Adams:

Attached is a complimentary copy of the 1987-88 Progress Report for the University of Missouri-Rolla Nuclear Reactor Facility.

Sincerely,

M Straka

Milan Straka
Reactor Manager

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Enclosure

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