UNIVERSITY OF MISSOURI-ROLLA
Missouri's Technological University

Nuclear Reactor Facility

Nuclear Reactor
Rolla, MO 6540:-0249
Telephone (314) 341-4236

April 30, 1993

Document Control Room
Attention: Director
Office of Nuclear Reactor Regulations
U.S. Nuclear Regulatory Commission
Mail Stop 10-D-21
Washington, D.C. 20555

Dear Sir:

Please find enclosed the Annual Progress Report 1992-93 for the University of Missouri-Rolla Reactor Facility (License R-79). This report is being filed under the reporting requirements of our Technical Specifications. A copy of this report is also being sent to our Regional Administrator and Project Manager.

Sincerely,

David W. Freeman
Reactor Manager

DWF/lp

Enclosure

xc: Marvin Mendonca, Project Manager (NRC)
A. Burt Davis, Region III Administrator (NRC)
Dr. A. E. Bolon, Reactor Director (UMR)
Dr. Don L. Warner, Dean, School of Mines & Metallurgy (UMR)
Mr. Ray Bono, Director, Envir. Health/Risk Management (UMR)
Dr. Robert L. Davis, Dean, School of Engineering (UMR)
Mr. Bruce Ernst, American Nuclear Insurers
Dr. Nord Gale, Chairman, Radiation Safety Committee (UMR)
Dr. John Fulton, Dean, College of Arts and Science (UMR)
Dr. John Park, Chancellor (UMR)
American Nuclear Insurers, c/o Librarian

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PROGRESS REPORT

1992-93

UNIVERSITY OF MISSOURI-ROLLA

NUCLEAR REACTOR FACILITY

UNIVERSITY OF MISSOURI - ROLLA

REACTOR

PROGRESS REPORT

FOR THE

UNIVERSITY OF MISSOURI-ROLLA

NUCLEAR REACTOR FACILITY

APRIL 1, 1992 TO MARCH 31, 1993

Submitted to
The U.S. Nuclear Regulatory Commission
and
The University of Missouri-Rolla

Albert E. Bolon, Director
David W. Freeman, Manager
Nuclear Reactor Facility
University of Missouri-Rolla
Rolla, Missouri
65401

SUMMARY

During the 1992-93 reporting period the University of Missouri-Rolla Reactor (UMRR) was in use for 398 hours. The major part of this time, about 60%, was used for class instruction and training purposes.

The UMRR operated safely and efficiently over the past year. No significant safety-related incidents or personnel exposures occurred.

In July 1992 the reactor fuel was converted from the original high-enriched uranium (HEU, 90% U-235) to new low-enriched uranium (LEU, 19.8% U-235). The HEU is presently stored in the fuel storage area at the end of the reactor pool.

The reactor facility supported several UMR courses over the year for a total of 1,972 student-hours. The reactor was visited by about 3,400 visitors during the past year. There were 536 participants in the U.S. Department of Energy Reactor Sharing Program.

The reactor produced 5,762 kilowatt hours of energy using approximately 0.297 grams of uranium. A total of 195 samples were irradiated at the reactor with most of them being analyzed in the Reactor Counting Laboratory.

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1.0 INTRODUCTION

This progress report covers activities at the University of Missouri-Rolla Reactor (UMRR) Facility for the period April 1, 1992 to March 31, 1993.

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

1.1 Background Information

The University of Missouri-Rolla Reactor Facility attained initial criticality on December 9th, 1961. The UMRR was the first operating nuclear reactor in the state of Missouri. The reactor design is based on the Bulk Shielding Reactor at Oak Ridge National Laboratory. The initial licensed power was 10 kW. The licensed power was upgraded to 200 kW in 1966. During the summer of 1992, the reactor fuel was changed from high-enriched uranium (HEU, 90% U-235) fuel to low-enriched uranium (LEU, 19.8% U-235) fuel. The fuel conversion went very smoothly.

The reactor is a light water open pool-type reactor cooled by natural convection flow. The fuel is MTR plate-type fuel.

The facility is equipped with several experimental facilities including a beam port, thermal column, pneumatic rabbit system and several manual sample irradiation facilities. Additionally, the facility is equipped with a counting laboratory with gamma and alpha spectroscopy capabilities. The gamma spectroscopy system includes germanium and sodium-iodide detectors, associated electronics, and modern spectrum analysis software. The alpha spectroscopy system consists of a surface barrier detector and data acquisition equipment.

1.2 Facility Status

The UMRR operated safely and efficiently over the past year. No significant safety-related incidents or personnel exposures occurred.

The LEU conversion project is nearly complete. The new fuel was received and loaded during the summer of 1992. Several core characterization studies have been completed with the new core.

We received a third grant award from DOE to aid in purchasing new nuclear instruments (NI) for the UMRR console. The cost of the upgrade is being shared directly from reactor funds. We plan to replace our existing five channel NI system with a three channel system. We have purchased and received three new instrument drawers from Gamma-Metrics; 1) a wide-range log fission chamber based drawer, 2) a wide range linear CIC based drawer, and 3) a log and linear CIC based drawer. We presently plan to install these three drawers in our control

console as direct replacements for our existing Start-up, Log N and Period, and Linear drawers under the provisions of 10CFR50.59. Parallel with this, we will be submitting a request to NRC for approval for desired console revisions that may involve "unreviewed safety questions".

The Reactor Facility was audited in May of 1992 by an independent audit team from the University of Missouri-Columbia Research Reactor. The audit team found that the facility's "overall operation is being conducted in a satisfactory manner". The audit team noted some areas of concern with regard to record keeping. Those concerns have been addressed by the facility management.

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. An "outreach" program, implemented last year, has been continued in order to let both students and faculty in a number of departments across campus know how the reactor could be used to enhance course work and research. As a result, several additional classes have used the Reactor Facility as a part of their laboratory courses.

Staffing at the facility was reduced in September, 1992. At that time, the Reactor Maintenance Engineer position was eliminated and the Senior Electronics Technician and Lab Mechanic took early retirement. The NRC Project Manager was notified of the staffing changes and a change in Technical Specifications was

initiated to remove reference to the Reactor Maintenance Engineer. The retired Senior Electronics Technician and Lab Mechanic have continued working at the facility on a part-time basis. A new Senior Electronics Technician, William Bonzer, was hired in December, 1992.

The following sections of this report are intended to provide a brief description of the various aspects of facility operations including the reactor's utilization for education and research.

2.0 REACTOR STAFF AND PERSONNEL

2.1 Reactor Staff

Name	Title
Albert E. Bolon	Director
David Freeman	Reactor Manager
Carl Barton[1)]	Senior Electronic Technician
Juls Williams[1)]	Lab Mechanic
Francis Jones[2)]	Reactor Maintenance Engineer
Linda Pierce	Senior Secretary
Matt McLaughlin	Reactor Operator
William Bonzer[3)]	Senior Electronics Technician

2.2 Licensed Operators

Name	License
Albert E. Bolon	Senior Operator
Carl Barton[1)]	Senior Operator
David Freeman	Senior Operator
Francis Jones[2)]	Senior Operator
Matt McLaughlin	Reactor Operator

[1)]Began part-time 9/1/92.

[2)]Position eliminated 8/31/92.

[3)]Employed effective 12/16/92.

2.3 Radiation Safety Committee

The Radiation Safety Committee is required to meet quarterly. The committee met on 6/29/92, 9/11/92, 12/2/92, and 2/24/93 during the reporting period. The committee members are listed below:

Name	Department
Dr. Nord L. Gale (chairman)	Life Sciences
Mr. Ray Bono (secretary, ex-officio, non-voting)	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. Arvind Kumar	Nuclear Engineering
Mr. David Freeman (ex-officio, non-voting)	Nuclear Reactor
Mr. Randy Stoll	Purchasing

2.4 Health Physics

Health Physics support is provided through the Environmental Health and Risk Management Department which is organizationally independent of the Reactor Facility operations group. Health Physics personnel are listed below:

Name	Title
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Mr. Ray Bono	Director, Environmental Health and Risk Management and Reactor Health Physicist
Mr. Charles Hooper	Student Assistant (HP)
Mr. Cary Lieurance[1)]	Student Assistant (HP)
Miss Lisa Stiles	Student Assistant (HP)
Mr. Chad Little[2)]	Student Assistant (HP)
Mr. Justin Hiller[3)]	Student Assistant (HP)

[1)]Terminated effective June, 1992.

[2)]Employed effective June, 1992.

[3)]Employed effective August, 1992.

3.0 IMPROVEMENTS

A continual effort is made to enhance safety, availability and reliability of the facility. In that effort the following improvements have been made at the facility during the reporting period:

1) Three new nuclear instrumentation drawers have been acquired from Gamma-Metrics. The three channel Gamma-Metrics system will ultimately replace our present five channel system. This is possible due to advanced technology that will allow a fission chamber based "wide-range" channel to both serve as a start-up channel and an Intermediate Log N and period channel. The other channel reduction is possible because advanced technology allows a linear high power scram trip to be set on each of the three channel drawers, thus the two existing Uncompensated Ion Chamber Safety Channels will not be needed.

   We have received additional funding with which we plan to purchase new strip chart recorders, a reactor trip relay logic drawer, and new annunciator panel. We plan to make many of the changes this summer under the provisions of 10CFR50.59. Other changes, requiring NRC approval will be made later, after all appropriate approvals have been obtained.

2) A campus outreach program has been continued over the past year. The program is designed to make UMR faculty and researchers outside of the Nuclear Engineering Department aware of reactor capabilities applicable to their specific disciplines. The program has been very successful and has resulted in significant increased reactor usage.

3) Several proposals have been written this year in hopes of securing funding for next year as summarized below:

PROPOSAL	DESCRIPTION	AMOUNT REQUESTED
1. DOE Upgrade & Instrumentation Needs	Identify funding needs over next five years for facility upgrade	$1,197,500
2. DOE Instrumentation Upgrade	Request funding for Instrumentation Upgrade	$ 490,960
3. DOE Reactor Sharing Program	Request funding to support University and pre-college students of the reactor	$ 26,136

4.0 REACTOR OPERATIONS

Core designation 101W is presently in use. The "W" mode core is completely water reflected and is used for normal reactor operations. The "T" mode (core positioned near graphite thermal column) may be used for various experiments including beam port and thermal column experiments.

Table 4-1 presents pertinent core data and Figure 4-1 shows the core configuration of core 101W. The excess reactivity, shutdown margin, and rod worths were measured in cold clean conditions.

Tables 4-2 and 4-3 present a listing of unscheduled shutdowns along with their causes and corrective actions.

Maintenance activities are listed in Table 4-4.

Table 4-5 shows facility use other than the reactor and Table 4-6 shows reactor utilization. Table 4-7 presents core loadings and unloadings over the past year.

Table 4-1. Core 101W Technical Data

Rod Worths:

Rod 1:	2.73% $\Delta k/k$
Rod 2:	2.69% $\Delta k/k$
Rod 3:	3.22% $\Delta k/k$
Reg Rod:	0.371% $\Delta k/k$

Excess Reactivity: 0.496% $\Delta k/k$

Shutdown Margin*: 4.92% $\Delta k/k$

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*) Rod 3 and Reg Rod are assumed to be fully withdrawn.

Figure 4-1. UMRR Core Configuration and Rack Storage Form

DATE July 28, 1992 LOADING NUMBER 101W

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
HEU	HEU	HEU	HEU	HEU	HEU	HEU		HEU	HEU	HEU	LEU	HEU	HEU	HEU
C-4	C-3	C-2	C-1	F-9	F-17	F-13	Empty	F-20	F-6	F-8	HR-1	F-14	F-22	F-12

RACK STORAGE FACILITY - HEU IN FUEL STORAGE

HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU	HEU
F-1	HF-1	F-7	F-11	F-4	F-10	F-5	F-2	F-15	HR-1	F-19	F-16	F-3	F-18	F-21
R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30

	1	2	3	4	5	6	7	8	9
A									
B					S				
C				F-8	F-4	C-4			
D			F-13	C-1	F-3	F-2	F-12	F-15	
E			F-10	C-2	F-1	C-3	F-9	F-14	
F			CR	F-5	F-6	F-7	BR		

UMRR CORE STATUS - LEU IN CORE

KEY TO PREFIXES

F - Standard Elements
C - Control Elements
HF - Half Front Element
HR - Half Rear Element
BR - Bare Rabbit
CR - Cadmium Rabbit
S - Source Holder

Table 4-2. SCRAMS

Date	Cause
04/22/92	150% Power Scram. Reactor operating at steady 200 kW. No indication of increase in power. Cause: Spurious electrical signal. Corrective Action: System checked, no problems identified. SRO grants permission for restart. Reactor restarted.
05/04/92	150% Power Scram. Reactor operating at steady 40 kW. Cause: Spurious electrical signal in safety amp. Corrective Action: System checked, no problems identified. SRO grants permission to restart. Restarted reactor.
08/11/92	150% Power Scram. Reactor operating at steady 40 kW. Cause: Spurious electrical spike in safety amp. Corrective Action: Checked relays. Could not duplicate problem. SRO permission to restart granted. Restarted reactor.
10/05/92	< 5 second Period Scram. Reactor subcritical during start-up. Cause: Appears to be spurious signal from Log N Amplifier. Corrective Action: SRO permission to restart granted. Reactor restarted.
11/02/92	150% power scram. Reactor operating at less than 200 kW. Cause: Scram due to setpoint adjustment too low. (Setpoint verified to be less than 150% during Pre-Startup Checklist. Corrective Action: Adjusted setpoint. SRO permission to restart granted. Reactor restarted.
03/05/93	150% Power Scram. Reactor operating at less than 10 W. Cause: Spurious signal in safety amp. Corrective Action: Checked cables. J-4 and J-20 were tightened. SRO permission to restart granted. Reactor restarted.
03/08/93	150% Power Scram. Reactor operating at 120 W. Cause: Spurious signal in safety amp. Corrective Action: System checked, no problems identified. SRO permission to restart granted. Reactor restarted.

Table 4-3. Rundowns

Note: Most of the rundowns listed below were due to switching problems in the Linear instrument while manually changing scales. A new Linear instrument has been purchased from Gamma-Metrics that, when installed, will eliminate the spurious rundown trips.

Date	Cause
04/29/92	120% Demand Rundown Cause: Student operator switched scales and switch button popped out on Linear. Corrective Action: Student given further instruction. SRO permission to restart granted. Reactor restarted.
05/04/92	120% Demand Rundown. Cause: Student operator did not upscale properly on Linear system. Correction Action: Student given further instruction. SRO permission to restart granted. Reactor restarted.
07/06/92	120% Demand Rundown. Cause: Switch on Linear picoammeter popped out. Corrective Action: Reset switch. SRO permission to restart granted. Reactor restarted.
09/02/92	120% Demand Rundown. Cause: 20 W button did not catch when down scaling Linear from 200 W. Corrective Action: Reset button. SRO permission to restart granted. Reactor restarted.
09/16/92	High radiation rundown. Cause: Noise spike. Corrective Action: Found radiation levels normal when checked with portable survey instrument. SRO permission to restart granted. Reactor restarted.
09/17/92	High Radiation Rundown. Cause: Noise spike. Corrective Action: Found radiation levels normal when checked with portable survey instrument. Replaced GM tube and recalibrated channel. SRO permission to restart granted. Reactor restarted.
10/22/92	120% Demand Rundown. Cause: Occurred while switching Linear from 2 kW scale to 20 kW scale. Corrective Action: SRO terminated rundown. SRO permission to restart granted. Reactor restarted.

Table 4-3. **Rundowns** (cont.)

Date	Cause
11/10/92	120% Demand Rundown. Cause: Student operator downscaled Linear system too soon. Corrective Action: Student given further instruction. SRO permission to restart granted. Reactor restarted.
11/13/92	120% Demand Rundown. Cause: Operator touching button on Linear and button popped out. Corrective Action: Cautioned operator. Senior Operator terminated rundown and granted permission to restart. Reactor restarted.
03/03/93	120% Demand Rundown. Cause: Operator improperly switched scale on Linear. Corrective Action: Cautioned operator. SRO permission to restart granted. Reactor restarted.

Table 4-4. Maintenance

Date	Cause
04/16/92	Problem: Semi-annual RAM maintenance. Cause: Routine maintenance. Corrective Action: Completed maintenance.
04/20/92	Problem: Linear meter malfunctioning, indicating a negative signal. Cause: System temporarily malfunctioned. Corrective Action: Checked picoammeter with current source. Checked good. Reconnected picoammeter to system.
05/27/92	Problem: Picoammeter reading a negative value. Cause: Bad transistor in picoammeter. Corrective Action: Picoammeter removed, repaired and replaced. System calibrated.
06/03/92	Problem: Semi-Annuals started. Cause: Routine. Corrective Action: Completed Semi-Annuals on 06/29/92.
07/16/92	Problem: Annual control rod inspection. Cause: Routine maintenance. Corrective Action: Control rod inspection completed. Reassembled and performed rod drop test.
08/11/92	Problem: Safety Channel Chamber No. 2 not indicating correctly while reactor was operating. Reactor shutdown. Cause: Found dial plate had moved causing meter needle to stop. Corrective Action: Glued dial plate in position.
08/13/92	Problem: Power Channel No. 2 not reading properly while Reactor at 40 kW. Reactor shutdown. Cause: Meter lens shifted and appeared to be rubbing on needle. Corrective Action: Meter lens repositioned.
08/25/92	Problem: Period recorder not operating. Cause: Damaged cable. Corrective Action: Repaired A.C. power line to chart carriage.

Table 4-4. Maintenance (cont.)

Date	Cause
09/02/92	Problem: Spurious spikes in RAM channel. Cause: Suspected bad GM tube. Corrective Action: Replaced GM tube in demineralizer RAM module and calibrated demineralizer channel.
09/18/92	Problem: Spurious spikes in RAM channel. Cause: Bad GM tube. Corrective Action: Replaced GM tube and calibrated demineralizer RAM module.
10/06/92	Problem: Malfunction of Safety Channel Chamber No. 1 while reactor operating at 100 W. Reactor shutdown. Cause: Suspected bad tube. Corrective Action: Replaced 5965 tube in preamp.
10/12/92	Problem: 150% Power Scram during weekly check. Reactor not operating. Cause: Checked connectors and tried to duplicate problem, but could not. Corrective Action: Removed UIC No. 1. Found moisture in it. Replaced UIC No. 1. SRO permission to restart granted. Reactor restarted.
10/19/93	Problem: Could not reset 150% power trip. Cause: Believed to be malfunction in preamp or amp. Corrective Action: System checked, appeared to be operating normally. Maintenance run requested.
10/19/92	Problem: Safety Channel No. 1 not reading properly while reactor operating. Reactor shutdown from 80 kW. Cause: Moisture in detector canister. Corrective Action: Dried canister, cleaned and reassembled. Detector replaced in core position.
10/21/92	Problem: Semi-annual RAM maintenance. Cause: Routine maintenance. Corrective Action: Completed maintenance.
10/30/92	Problem: Safety Channel Chamber No. 1 not responding properly while reactor operating. Reactor shutdown before 40 kW. Cause: Faulty signal in preamp or detector. Corrective Action: Checked detector and repaired preamp.

Table 4-4. Maintenance (cont.)

Date	Cause
11/06/92	Problem: Safety Channel No. 1 detector not responding properly with reactor shutdown. Cause: Bad detector insulator. Corrective Action: Removed detector and replaced.
11/06/92	Problem: Safety Channel No. 1 not responding properly while reactor operating at 20 kW. Reactor shutdown. Cause: Bad cable connector. Corrective Action: Replaced connector.
01/07/93 to 01/20/93	Problem: Semi-annual Console Maintenance. Cause: Routine maintenance. Corrective Action: Maintenance completed.
02/08/93	Problem: Low CIC annunciator. Cause: No H.V. output from Log N power supply. Corrective Action: Replaced two rectifiers. Checked for proper operation.

Table 4-5. Facility Use Other Than The Reactor

Facility	Hours
Bare Rabbit Tube	11
Cadmium Rabbit Tube	0.4
Other Core Positions	13.3
Total	24.7

Table 4-6. Reactor Utilization

1.	Reactor use	398 hr
	a. Research and irradiation runs	84.7 hr
	b. Instruction runs	184.6 hr
	c. Maintenance runs	74.0 hr
	d. Training	54.6 hr
2.	Time at power	175.7 hr
3.	Energy generated	5762 kw-hr
4.	Total number of samples	195
5.	Sample hours	24.7 hr
6.	U-235 burned	0.251 g
7.	U-235 burned and converted	0.297 g

Table 4-7. Core Loading and Unloading

Date	Action
07/16/92	Unloaded HEU Core 74W in preparation for new fuel.
07/22/92	Started loading core with LEU.
07/23/92	Reactor went critical for the first time (no core designation) with LEU fuel.
07/24/92	Element HR-1 (half-element) was added to increase core excess reactivity. Core loading designated as 100W.
07/28/92	Element HR-1 was replaced with full element F-15. Core loading designated as 101W.

5.0 PUBLIC RELATIONS

The reactor staff continues to educate the public about applications of nuclear science. Over 3,400 persons toured the facility during this reporting period. Tour groups are typically given a brief orientation and/or demonstration by a member of the reactor staff.

Table 5-1 lists some of the major occasions or groups and number of visitors for each event.

Table 5-1. Public Relations Program

DATE	PARTICIPANTS	NUMBER
04/11/92	UMR Spring Open House	158
04/14/92	Ft. Leonard Wood S.A.M.E.	10
04/14/92	UMR Thomas Jefferson Dorm, 2 North	9
05/14/92	St. Pat's 5th Grade	10
05/20/92	UMR Police	5
06/08/92	Jackling Institute, UMR	49
06/08/92	Fundamentals of Engineering, UMR	16
06/09/92	Fundamentals of Engineering, UMR	18
06/10/92	Fundamentals of Engineering, UMR	17
06/12/92	Fundamentals of Engineering, UMR	22
06/15/92	Jackling Institute, UMR	30
06/22/92	Jackling Institute, UMR	44
06/25/92	Elementary Teachers' Tour	19
07/07/92	UMR Police	4
07/12/92	Salem Avenue Mixed Adult Sunday School Class	17

Table 5-1. Public Relations Program		
DATE	PARTICIPANTS	NUMBER
07/20/92	High School Teachers' Tour	9
08/03/92	Fundamentals of Engineering, UMR	18
08/04/92	Fundamentals of Engineering, UMR	22
08/05/92	Fundamentals of Engineering, UMR	16
08/06/92	Fundamentals of Engineering, UMR	7
08/10/92	Fundamentals of Engineering, UMR	17
08/11/92	Fundamentals of Engineering, UMR	7
08/12/92	Fundamentals of Engineering, UMR	16
08/13/92	Fundamentals of Engineering, UMR	64
08/14/92	Fundamentals of Engineering, UMR	2
08/31/92	Retirement Reception	6
09/26/92	Parent's Day Open House, UMR	176
10/17/92	UM-Rolla Day Open House, UMR	343
11/12/92	Cub Scouts of St. James	9
11/20/92	National Society of Black Engineers	26
02/02/93	Kiwanis Club of Rolla	13
02/18/93	Teams Testing (Basic Engineering)	45
02/20/93	Boy Scout Merit Badge	13
03/07/93	Chemistry Recruiting Tour	26
03/17/93	Freshman Engineering, UMR	7
03/23/93	Freshman Engineering, UMR	9
03/24/93	Freshman Engineering, UMR	5

6.0 EDUCATION UTILIZATION

The reactor facility supported several UMR courses over the past year for a total of 1,972 student-hours. The number of UMR students utilizing the facility was 1,062, over twice as many as last year. This increased usage is a direct result of an aggressive "outreach" program started last year. The reactor facility provided financial support for three students with hourly wages and one PhD candidate with a partial Graduate Research Assistantship. Additionally, students from several universities, colleges and high schools have used the facility.

Table 6-1 lists UMR classes taught at the facility along with associated reactor usage for this reporting period.

The Reactor Sharing Program, which is funded by the U.S. Department of Energy, was established for colleges, universities, and high schools which do not have a nuclear reactor. About 540 students and their instructors participated in this program. Table 6-2 lists those schools and groups that were involved in this year's Reactor Sharing program.

Nuclear Engineering graduate students at the University of Missouri-Columbia visited the UMR Reactor twice over the past year to perform various reactor experiments. Each laboratory session lasted about 4 1/2 hours and covered a wide variety of reactor experiments. Although UMC possesses a reactor facility, it is typically unavailable for student use for the types of experiments performed at UMR. Thus, the UMR facility complements

the larger UMC research reactor facility by providing a unique facility for reactor laboratory courses. Next year, the number of laboratories provided to the UMC students will be increased from two to three four-hour sessions.

Beginning this year, the UMR Reactor facility has also been providing day long operator training sessions for licensed operators from at the UMC Reactor. Because of our facility's availability and design, the operators receive unique training. Presently, we plan to provide operator training sessions to the UMC operators on a regular basis.

Table 6-1. UMR Classes at Reactor Facility
1991-92 Reporting Period

DATE	CLASS NUMBER/TITLE	# OF STUDENTS	TIME AT REACTOR (hrs)	STUDENT HOURS
Fall 92 Winter 93	NE 300, Nuclear Special Problems	2	60.0	120.0
Fall 92	NE 304, Reactor Laboratory I	10	53.0	530.0
Fall 92 Winter 93	NE 306, Reactor Operations	7	72.0	504.0
Winter 93	NE 308, Reactor Laboratory II	8	25.0	200.0
04/13/92	Chem II Laboratory	36	0.5	18.0
04/14/92	Chem I Laboratory	33	0.5	16.5
04/15/92	Chem II Laboratory	22	0.5	11.0
05/08/92	Physics 107, Intro to Modern Physics	54	1.0	54.0
09/21/92	NE 205, Fundamentals of Nuclear Engineering	19	1.0	19.0
10/05/92	Chem II Laboratory	80	0.5	40.0
10/06/92	Chem II Laboratory	232	0.5	116.0
10/07/92	Chem II Laboratory	147	0.5	73.5
10/08/92	Chem II Laboratory	253	0.5	126.5
12/11/92	Physics 107, Intro to Modern Physics	36	0.5	18.0
01/28/93	Life Science 301, Biological Effects of Radiation	7	1.0	7.0
02/22/93	Chem II Laboratory	69	0.5	34.5
02/24/93	Chem II Laboratory	35	0.5	17.5
03/05/93	UMC NE 404, Nuclear Laboratory	6	5.0	30.0
03/08/93	UMC NE 404, Nuclear Laboratory	6	6.0	36.0
	TOTAL	1,062	229.0	1,971.5

Table 6-2. Reactor Sharing Program		
DATE	PARTICIPANTS	NUMBER
04/09/92	Washington High School, Rick Schwentker, Instructor	36
04/16/92	Whitfield High School, Tom Rodgers, Instructor	22
04/21/92	Hazelwood East High School, Deborah McKenzie, Instructor	23
04/21/92	Hazelwood Central High School, Linda Kralina, Instructor	8
04/24/92	Kingdom City Junior High School	13
04/28/92	St. Charles High School	21
04/30/92	Sullivan High School, Marcene Abel, Instructor	20
05/01/92	Potosi Gifted 8th Grade, Alan Ziegler, Instructor	12
05/04/92	Vienna High School, Geraldine Fritchey, Instructor	13
05/05/92	Seckman Junior High School,	11
05/08/92	Van Buren High School, Daniel Freeman, Instructor	16
05/14/92	Lebanon 8th Grade, Julie Webb, Instructor	68
07/02/92	Dixon High School, Ellen Alexander, Instructor	8
07/29/92	Rolla Vo-Tech Radiology, Barbara Currie, Instructor	11
09/29/92	Maries County High School, Belle, George Cowgill, Instructor	16
10/02/92	Laclede County High School, Conway, Phil Davis, Instructor	15
11/19/92	Rolla Middle School, Jackie Loudermilk, Instructor	57
11/24/92	Sullivan High School, Jim Abel, Instructor	10
12/10/92	Blair Oaks High School, Anthony Schnell, Instructor	45
01/28/93	St. Francis Borgia, Sister Mary Paul, Instructor	14

Table 6-2. Reactor Sharing Program		
DATE	PARTICIPANTS	NUMBER
02/10/93	Rolla Vo-Tech Radiology, Barbara Currie, Instructor	13
03/00/93	Jamie McGinnis, Potosi High School, Bill Nelson, Instructor	1
03/00/93	Juan McGinnis, Potosi High School, Bill Nelson, Instructor	1
03/00/93	Chris Rolens, Potosi High School, Bill Nelson, Instructor	1
03/03/93	Hazelwood High School, Gail Haynes, Instructor	19
03/17/93	St. Charles West High School, Rebecca Teague, Instructor	35
03/25/93	Washington High School, Rick Schwentker, Instructor	27
	TOTAL	536

7.0 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.

A. Routine Surveys

Monthly radiation exposure surveys of the facility consist of direct gamma and neutron measurements. No unusual exposure rates were identified. Monthly surface contamination surveys consist of 20 to 40 swipes counted separately for alpha, and beta/gamma activity. No significant contamination outside of contained work areas was found.

B. By-Product Material Release Surveys

There were no shipments of by-product material released off-campus from the reactor facility during this reporting period.

C. Routine Monitoring

Thirty-one reactor facility personnel and students involved with operations in the reactor facility are currently assigned film badges. Six are read twice per month (Reactor Staff) and twenty-five are read once per month (students). There are four area beta-gamma/neutron badges assigned. 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 22 monitor and spare badges assigned on campus. In addition, 4 to 7 direct-reading dosimeters are used for visitors and high radiation area work. There have been no significant personnel exposures during this reporting period.

Visitors are monitored with direct reading dosimeters. No visitor received in excess of an indicated 8 millirem.

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

Pool water activity is monitored monthly to ensure that no gross pool contamination or fuel cladding rupture has occurred. Gross counts and spectra of long-lived gamma activity are compared to previous monthly counts. From April 1992 through March 1993 sample concentrations averaged 5.25×10^{-6} μCi/ml.

D. <u>Waste Disposal</u>

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 38.9 millicuries were released into the air. The 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 ion-exchange column. The water is analyzed for radioactive contamination and approval is required before the water is released. During this period four releases associated with resin regeneration were discharged to the sanitary sewer totaling approximately 12,112 gallons of water with a total gross activity of less than 330 microcuries.

E. <u>Instrument Calibrations</u>

During this period, portable instruments and area monitors were calibrated at six month intervals.

8.0 PLANS

The reactor staff will be heavily involved in four major projects during the next reporting period; 1) procuring, testing and installing the new reactor nuclear instrumentation (NI), 2) preparing to ship HEU fuel offsite, 3) continued characterization of the LEU fuel and core, and 4) continued expansion of research capabilities.

A. Reactor Instrumentation Upgrade

We have recently acquired three new NI channels from Gamma-Metrics which will ultimately replace our existing five channel system.

As instruments are procured, extensive review documentation will be established and appropriate approvals will be obtained. NRC will be notified of our intended changes in a timely fashion.

Detailed testing will be performed and extensive operational data will be collected prior to actually replacing the equipment.

We have great hopes of receiving additional funding through the DOE Instrumentation Program in order to complete the needed NI upgrade.

B. Shipment of HEU Fuel Offsite

Efforts will continue during the next reporting period to ship our HEU fuel offsite. We hope to complete the project within the next year. Studies have been completed to help

project dose rates that will be associated with each element. More detailed measurements are planned.

Once the HEU fuel is shipped offsite, we plan to submit a revised Security Plan for NRC review and approval to modify our current security requirements.

C. <u>LEU Fuel Characterization</u>

We have written a proposal requesting funding to continue characterization studies. In particular, we plan to perform detailed flux mapping and spectrum measurements, as well as to measure kinetics parameters.

D. <u>Expansion of Research Capabilities</u>

Over the next year, efforts will continue to expand the facility's research capabilities. In particular, we are placing much emphasis on computer interfacing with the new console equipment. The new equipment has been specially designed to provide isolated signal outputs dedicated to interfacing with computer data acquisition stations. There is great faculty interest in this capability with planned research in the areas of artificial intelligence, neural networking and an "operator advisory" system.

We have several outstanding proposals for funding to significantly upgrade our research equipment including a new pneumatic rabbit system, an upgraded beamport facility, new spectroscopy equipment and precise pool flow distribution

measurement equipment. We are optimistic that we will receive some funding for the above mentioned items. We plan to continue to aggressively seek funding for research equipment over the upcoming year.

APPENDIX A.

STANDARD OPERATING PROCEDURES CHANGED DURING THE PAST YEAR

A. Purpose:

To provide for the safe and efficient movement of fuel elements and control rod fuel elements to and from the core and the Fuel Storage Rack.

B. Precautions, Prerequisites, and Limitations:

1. Movement of fuel shall be performed under the direct supervision of a Senior Reactor Operator.

2. The Health Physicist or his designee shall be present to monitor radiation levels whenever fuel or control rods are being installed in or unloaded from the core.

3. All fuel movements shall be logged in the permanent log book.

4. Prior to any fuel movement, a completed Transfer Order Form must be filled out and approved by either the Reactor Manager or Reactor Director.

5. When moving fuel elements, the fuel handling tool must be kept in a vertical attitude.

6. A licensed operator shall visually confirm that there are no unoccupied internal lattice positions in the core before a new core is taken critical.

7. When loading to a new core configuration, measure the core excess reactivity, shutdown margin, and rod worths prior to exceeding a power of 1 kW. Log this information on a Core Data Sheet.

8. When loading to a new core configuration that involves a reactivity change greater than 0.2% delta-k/k or changes in control rod locations, excess reactivity and shutdown margin must be determined for both the "W" and "T" modes.

Written By: David Freeman
David Freeman

Approved By: Albert Bolon
Albert Bolon

C. <u>Procedure:</u>

I. Unloading of Fuel Elements (unrodded) from the Core to the Fuel Storage Rack.

1. Complete a Start-Up Checklist (SOP 102).

2. Withdraw shim/safety Rods 1, 2 and 3 to shim range.

3. Unlock the fuel handling tools.

4. In accordance with the Transfer Order Form, the person with the fuel handling tool will request permission to move the fuel element. Example: "Request permission to move fuel element F1 from grid position D7 to rack storage R10".

5. With the Control Room Operator's approval, latch the fuel element with the handling tool. Announce, "Tool latched".

6. The Control Room Operator will then grant permission to remove the fuel element from the core.

7. Withdraw the assembly from the core. When the fuel handling tool and attached element have cleared the core grid plate, announce, "Element clear".

8. Move the element to the fuel storage end of the pool.

9. Rotate the fuel element 180° so that the bow of the fuel element remains toward the center of the pool.

10. Insert the fuel element into the designated location and check to ensure that it is properly seated in the fuel rack. Announce "Element seated".

11. Unlatch the fuel handling tool.

12. The Control Room Operator shall log the fuel movement in the permanent log book.

13. Transfer the element identification tag from the core status board to the fuel storage status board.

14. Repeat Steps 4 through 13 to remove additional elements from the core.

15. Lock the fuel handling tool in its holder and return the key to the safe.

16. Complete the necessary information on the Transfer Order form.

17. Perform a Reactor Secured Checklist (SOP 105) as appropriate.

II. Unloading of Control Rod Fuel Elements from the Core to the Fuel Storage Rack.

1. Unload fuel elements from the core (per Section I of this procedure) such that the core loading is below one-half of a critical mass. A single control rod fuel assembly may be removed from the core with this loading.

2. Unload all of the fuel elements from the core if two or more control rod fuel elements are to be removed.

3. Disconnect and uncouple the control rod drive, shroud and magnet extension.

4. Remove the shroud and magnet extension from the control rod element.

5. Remove the control rod from the element, if desired.

6. To unload, complete Steps 3 through 17 of Section I of this procedure.

Note: The control rod fuel element may be transferred to an appropriate "basket" to facilitate easy movement within the pool.

Written By: David Freeman **Approved By:** Albert Bolon

David Freeman Albert Bolon

III. Loading of Fuel Elements from the Fuel Storage Rack to the Core

1. The Control Room Operator must comply with SOP 106 (Approach to Critical) during the loading of the core. The Control Room Operator will be responsible for collecting the necessary data, constructing the 1/M plot and instructing fuel handlers as to assemblies that may be loaded.

2. All control rod fuel elements and control rods must be installed in the core per Section IV prior to the loading of any fuel element.

3. Control rod drop times must be completed per SOP 813 on all rods of control assemblies that have been moved or that have had their magnet assemblies removed and reinstalled prior to the loading of any fuel element.

4. Complete Steps 1, 2, and 3 from Section I of this procedure.

5. In accordance with the Transfer Order Form, the person with the fuel handling tool will request permission to move the fuel element. (Example "Request permission to move fuel element F1 from storage rack R10 to grid position D7.")

6. With Control Room Operator approval, latch and remove the fuel element from the storage rack, transport the element to the edge of the core grid plate and announce, "Approaching core".

7. Wait for the Control Room Operator's approval prior to movement into the core area. Following the Control Room Operator's approval, place the fuel element in the core. The fuel element must be rotated 180° so that the bow of fuel points to center of pool.

8. When the element is seated, announce, "Element seated". Do not unlatch the fuel. Be prepared to immediately remove the fuel element from the core if instructed by the Control Room Operator.

9. With Control Room Operator approval, unlatch the element and move the tool clear of the core area. Announce, "Tool clear".

10. The Control Room Operator shall log the fuel movement in the permanent log.

11. Transfer the identification tag for the element from the fuel storage status board to the core status board.

12. To load additional fuel elements, repeat Steps 5 through 12 as instructed by the Control Room Operator.

13. When loading is complete, complete Steps 15, 16, and 17 of Section I of this procedure.

IV. Loading Control Rod Fuel Elements from the Fuel Storage Rack to the Core.

1. Complete a Pre-Startup Checklist to the extent possible. The 2 cps interlock may need to be bypassed by an SRO and other steps such as dropping rods may be omitted when no control rods are loaded in the core.

2. Load all of the control rod fuel elements in accordance with Steps 5 through 12 in Section III.

3. Insert control rods and reassemble the drive mechanisms.

4. Check the withdraw and insert control, observe the rod position indication, and ensure proper operation of the control rod drive system.

5. Perform Rod Drop Times (SOP 813) on all rod assemblies that have been moved or whose magnet assemblies have been removed and reinstalled.

6. If fuel loading is to continue go to section III of this procedure, otherwise complete Steps 15, 16, and 17 of Section I of this procedure.

Written By: David Freeman Approved By: Albert Bolon

TRANSFER ORDER FORM

Description of Fuel Movement ______________________________
Loading Number ______________________________

ELEMENT ID	FROM	TO	COMMENTS

Authorized by ________________ (Reactor Manager or Director)

Accomplished by 1 ____________
2 ____________

Date ________________

Date completed ____________

Written By: David Freeman
Approved By: Albert Bolon

UMRR CORE AND RACK STORAGE FORM

DATE ____________ LOADING NUMBER ________

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15

RACK STORAGE FACILITY

R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30

	1	2	3	4	5	6	7	8	9
A									
B									
C									
D									
E									
F									

UMRR CORE STATUS

Core Excess Reactivity ____________
Shut-Down Margin ____________
Rod Worths
Rod 1: ______ Rod 3: ______
Rod 2: ______ Reg Rod: ______

Elem.	U-235 Mass	Elem.	U-235 Mass	Elem.	U-235 Mass

Total U-235 Mass (Grams) __________

Review and Approval: ______________________________
(Reactor Director or Manager)

Written By: David Freeman Approved By: Albert Bolon

A. Purpose

To provide guidance for compliance with the Physical Security Plan.

B. Precaution, Prerequisites and Limitations

1. The door to the front office of the reactor building will be locked at all times with electrical access control at the secretary's desk.

2. Entry or exit to the building from other than the front office shall require the continuous presence of an authorized individual and permission of the Reactor Staff.

3. Individuals granted unescorted access will be issued identification badges. The ID badge will be worn while in the facility. ID badges are not to be worn outside of the building. The ID badges are to be returned to the badge rack when exiting the facility.

4. Authorized faculty and staff may escort visitors inside of the facility.

5. Authorized students may escort visitors inside of the facility only if they are designated in writing as escorts.

6. Escorts shall be capable of maintaining visual contact and shall remain in the same general area as their visitors.

7. Visitors to the facility must sign the Visitors Log and be issued a radiation dosimeter.

8. The visitor-to-escort ratio shall not exceed 20-to-1 unless authorized in writing by the Reactor Director or Reactor Manager.

9. Packages leaving or entering the nuclear reactor facility (with the exception of the office area) are subject to random search by the reactor staff.

10. Packages leaving/entering the facility larger than 2"x2"x10" are to be searched.

11. In the event of a situation which could affect the security of the facility, the reactor will be shutdown and the magnet key secured.

12. The reactor staff and students shall not enter into confrontation with any persons, except to provide for their personal safety.

C. <u>Procedure</u>:

1. Three or less visitors seeking entry to the facility.

   a. If a visitor's identity is unknown, they shall be allowed access only by direct action of the reactor staff. Access shall not be allowed by remote electric control.

   b. Require identification, from unknown individuals prior to allowing access to the restricted area unless the individual(s) are participating in a general tour of the facility.

   c. Visitor should leave books, packages, etc. in the office area.

   d. Issue the individual a dosimeter after recording its initial value and identification number in the Visitors Log.

   e. The visitor is to complete the necessary information in the Visitors Log.

   f. Prior to departure, retrieve the dosimeter and record the final reading and departure time in the Visitors Log.

2. Four or more visitors seeking entry to the facility.

   a. All steps of SOP 208.C.1 above apply with the exception that three dosimeters may be placed in the bay area at suitable locations. The maximum dosimeter radiation value obtained will be credited to all visitors during their visit.

Written By: David Freeman
David Freeman

Approved By: Albert Bolon
Albert Bolon

A. PURPOSE

To ensure that the Reactor Facility is properly secured whenever the facility is to be left unoccupied.

B. PRECAUTIONS, PREREQUISITES, OR LIMITATIONS

1. This procedure is to be completed at the end of each workday or whenever the building is to be left unoccupied by authorized personnel.

2. A person who has been authorized to have the necessary keys shall secure the building. (This includes members of the University Police.)

3. If the intrusion alarm system is inoperable, contact a Senior Reactor Operator to inform them of the difficulty, and remain at the office area until relieved by a member of the University Police or another person who has Unescorted Access clearance.

4. If a person who has been authorized to have the necessary keys is not available to secure the facility, then the University Police should be contacted to secure the building. In that case a member of the Reactor Facility staff should remain in the office area until a member of the University Police who has the proper keys arrives. The University Police should be reminded of SOP 209 for guidance in the proper securing of the building.

C. PROCEDURE

1. Verify that the bay door, basement door, fuel handling tools and lock box are properly locked.

2. Turn off building ventilation fans.

3. Turn off interior building lights. At least one light should be left on in the Reactor Bay and in the sub-basement level.

Written By: David Freeman Approved By: Albert Bolon

David Freeman Albert Bolon

4. Generally check the building to verify that no personnel remain, that there are no unusual packages or suspicious objects, nor fire hazards present.

5. Turn off or unplug appliances such as fans, coffee pots, sealing heater, etc., which do not need to be left on.

6. Activate the intrusion alarm system and lock the main personnel access door.

7. Check the security badge rack to make certain all of the security badges are properly accounted for.

8. Notify the University Police that the building has been secured and the alarm system has been activated.

Written By: David Freeman
David Freeman

Approved By: Albert Bolon
Albert Bolon

A. PURPOSE

To assure that the Nuclear Reactor Facility is occupied whenever the intrusion system is inoperative.

B. PRECAUTIONS, PREREQUISITES, OR LIMITATIONS

1. The Reactor Building shall be occupied whenever the intrusion system is non-operative.

2. In case of an immediate danger (e.g. earthquake, tornado, etc.), the preservation of human life takes precedence.

C. PROCEDURE

1. A person who has been granted an unescorted access or who is a member of the University Police (including unarmed watchmen) must be present in the Reactor Building as soon as possible after it has been determined that the intrusion alarm system is inoperable.

2. A Senior Reactor Operator should be notified as soon as possible after determining the alarm system is inoperable.

Written By: David Freeman
David Freeman

Approved By: Albert Bolon
Albert Bolon

A. Purpose

To assure compliance with Licensed Material quantity limits at the Reactor Facility.

B. Precautions, Prerequisites and Limitations

1. This procedure is not intended to serve as sole guidance for receipt of licensed materials. The scope of this procedure is limited to assuring compliance with inventory limits specified in the license.

2. This procedure should be performed prior to the receipt of any licensed material. Licensed materials include enriched uranium (e.g. fuel, fission chamber, flux foils) and sealed PuBe sources.

C. Procedure:

1. Complete the Receipt of Licensed Material Approval Form as follows:

   a. Determine the amount of licensed material onsite by examining the latest DOE/NRC 742, 742C and 741C forms. Record this information in the "Present Onsite Inventory" column of the approval form.

   b. Specify the amount of licensed material to be received in an incoming shipment in the "Inventory of Proposed Shipment" column of the approval form.

   c. Project the total amount of licensed material that will be present after the incoming shipment is received by summing values in the "Present Onsite Inventory" and "Inventory of Proposed Shipment" columns.

Written By: David Freeman Approved By: Albert Bolon

d. Compare the projected total amount of licensed material calculated in Step 1.c. with current license limits to assure that the projected total will comply with license limits.

e. Record the anticipated date of the shipment.

2. Have the Reactor Director or Reactor Manager review and approve the form prior to receipt of any licensed material shipment.

Written By: David Freeman

Approved By: Albert Bolon

RECEIPT OF LICENSED MATERIAL APPROVAL FORM

Material Description	License Limit	Present Onsite Inventory	Inventory of Proposed Shipment	Projected Inventory After Shipment
1. U-235 (< 20 w/o)	5.50 kg	______	______	______
2. U-235 (> 20 w/o)	4.95 kg	______	______	______
3. Pu-239 (Sealed Sources)	0.200 kg	______	______	______
4. Fission Chambers and Flux Foils (U-235)	0.050 kg	______	______	______

5. Does Projected Material Inventory Meet License Limits? _____ Yes _____ No

6. Approximate Anticipated Date of Shipment ____________________

Performed by: Title ________________________ Date: ______________

Signature ____________________

Approved by: Signature ____________________ Date: ______________
(Reactor Director or Reactor Manager)

Written By: David Freeman

Approved By: Albert Bolon