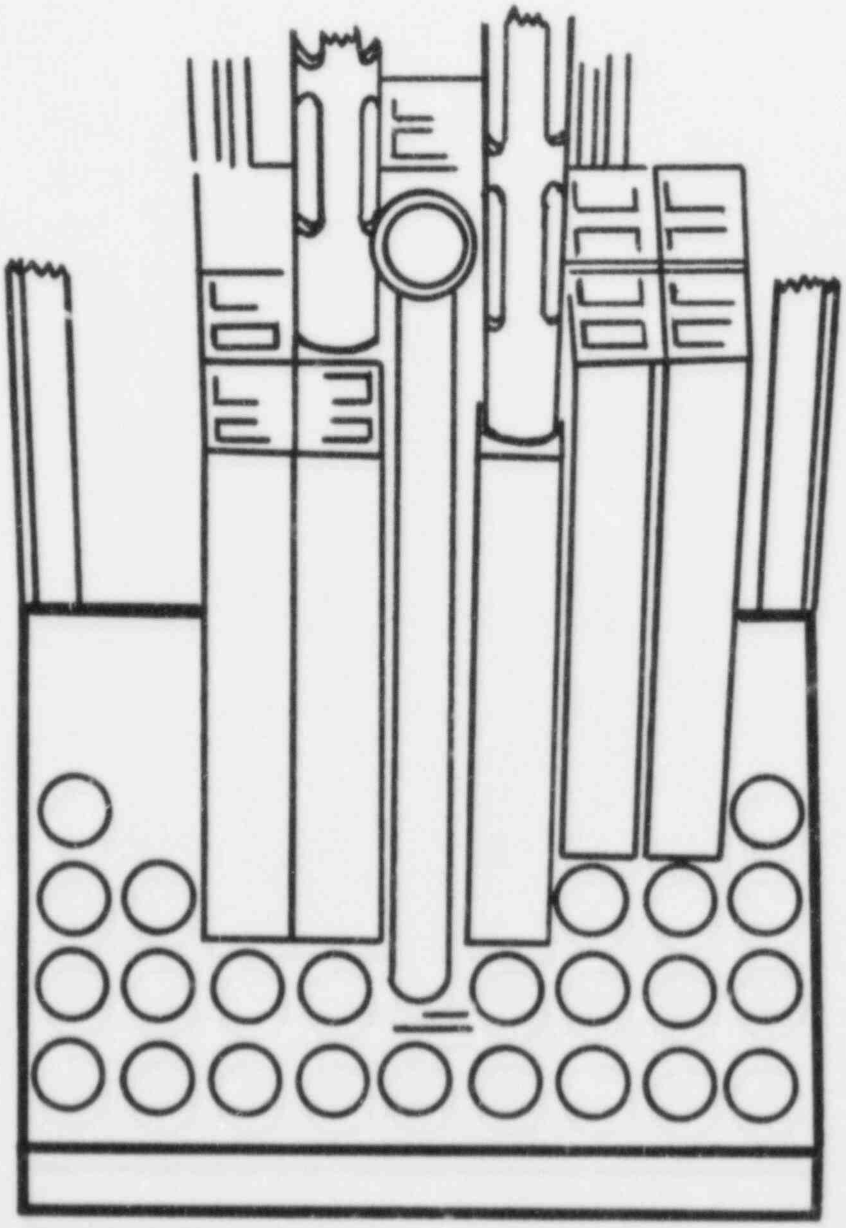
Progress Report

1983-1984

University of Missouri-Rolla

Nuclear Reactor Facility



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PROGRESS REPORT
FOR THE
UNIVERSITY OF MISSOURI - ROLLA
NUCLEAR REACTOR FACILITY

APRIL 1, 1983 to MARCH 31, 1984

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

By
Albert E. Bolon, Director
Milan Straka, Manager
Nuclear Reactor Facility
University of Missouri - Rolla
Rolla, Missouri
65401

Summary

During this reporting period the nuclear reactor at the University of Missouri-Rolla was in operation about 425 hours. The major part of this time, 84%, was used for class instruction and training purposes. About 6% of the reactor time was used for research and irradiation and about 10% was needed for the maintenance runs.

There were 30 UMR students enrolled for courses at the Reactor Facility. The facility was thus committed to over 48 student-hours of classes during the fall, summer, and spring semesters. The reactor was visited by 2,969 visitors during the past year. This is an increase of 36% when compared to the last reporting period.

An educational program was established for students and their instructors from colleges and universities which do not own a nuclear reactor. The Reactor Facility is reimbursed for this program from the Reactor Sharing Program funded by the Department of Energy. There were about 101 participants in this program.

The reactor produced approximately 6.3 MW-hrs of energy using 0.325 g of U-235. A total of 387 samples were irradiated during this reporting period with most of them being used and analyzed at the reactor facility. Furthermore, three research projects for material irradiation and neutron activation analysis were established for on-campus investigators. The reactor staff was heavily involved in the process of the license renewal for the facility.

Research activities at the reactor concentrated on the neutron flux evaluation at different irradiation positions and on further improvements in the trace

element analysis. Two papers on the facility uses and on-going programs were presented at an International Meeting in Cambridge, Mass.

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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, modified BSR, was first licensed as a 10 kW training and research facility with initial criticality on December 9, 1961. In January 1967 an amendment was granted by the Nuclear Regulatory Commission to upgrade the facility, allowing an increase in power level to 200 kW.

The Nuclear Reactor Facility 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.

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
Daniel Carter	Reactor Maintenance Engineer
Carl Barton	Electronic Technician
Karen Lane	Sr. Secretary
Juls William	Lab Mechanic
Scott Linn	Student Assistant Level II

B. Licensed Operators

Name	License
Albert E. Bolon	Senior Operator
Daniel Carter	Senior Operator
Carl Barton	Senior Operator
Karen Lane	Reactor Operator
Milan Straka	Reactor Operator

C. Radiation Safety Committee

Name	Department
Dr. Nord L. Gale (chairman)	Life Sciences
Mr. Ray Bono (secretary) (ex officio)	Health Physicist
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

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	Campus Health Physicist
Ms. Paula Brewer	Health Physics Technician

E. Independent Audit

Independent audits of the facility consisting of reviewing all records, procedures, and operating methods are performed semi-annually. Dr. Franklin Pauls, former Reactor Director, performed the first audit for the reporting period in May 1983. The second audit, in January 1984, was performed by Dr. J.C. McKibben and Mr. Barry Bezenek, both from the University of Missouri Research Reactor located at Columbia. Reports about both audits are enclosed in Appendix A.

III. Supporting Facilities

Several supporting facilities are either operated or maintained by the reactor staff for users of the reactor. These greatly contribute to the efficiency of research and educational programs available to the faculty and students of the University of Missouri-Rolla, as well as other universities.

Analog Computer: This computer is currently available to faculty and students and is used in scheduled classes for both graduate and undergraduate students. Several units of auxiliary equipment are also available to widen the scope of its operation.

Activation Analysis Laboratory: The activation analysis laboratory has proven to be the most-utilized supporting facility. The laboratory contains a 4096 channel analyzer, with NaI or GeLi selectable detector input. Included in the auxiliary equipment is a tape punch, multi-scaler programmer, a scope camera, and a teletype terminal. Three scalers are included in the laboratory equipment with the appropriate detectors for counting alpha, beta, and gamma radiation. A shielded detector with four ton low-background lead shield housing two "3X3" sodium iodide crystals, is also available for coincidence counting. These detectors are used in conjunction with the multi-channel analyzer. Several other units of equipment are available for the detection and evaluation of radioactive materials.

Pneumatic Tube Assembly: A dual tube pneumatic system is installed adjacent to the core of the reactor. One tube is cadmium lined, and the other is bare. This system is a positive pressure type and uses nitrogen as the propellant.

Dynamic Void: A method of introducing a contained void on the periphery of the core is available. This allows for a variation in void as a function of core height, total volume, or volume change.

IV. 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) More reactor staff personnel became licensed by the NRC. The facility has now 3 Senior Reactor Operators and 2 Reactor Operators licensed.
2) Input for the Fuel Burnup program was switched from the card deck to the terminal reader.
3) Multichannel Analyser is being interfaced with a Apple II$^+$ computer.
4) Some signal and power supply cables were provided with shields to protect against mechanical damage.

V. 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 and is periodically checked for all parameters listed in Table 8 (core data).

Tables 2 through 7 give pertinent information about the reactor facility and its operation during the reporting period. Listing of semi-annual facility checks is included in Appendix B.

Table 1. UMRR Core Configuration and Rack Storage Form

DATE December 19, 1978 LOADING NUMBER 67T or 67W*

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

RACK STORAGE FACILITY

R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30
				F-13	F-20	HF-1	F-22	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
CA - Core Access Element
IP - Isotope Production Element
S - Source Holder
Other BRT- Bare Rabbit Tube
CRT- Cadmium Rabbit Tube

Elem.	Pos.	Mass	Elem.	Pos.	Mass	Elem.	Pos.	Mass
HR-1	C3	84.912	F-16	D5	170.270	F-12	E7	168.774
F-8	D3	170.229	F-19	E5	170.264	F-10	D8	170.193
F-6	E3	169.160	F-15	F5	168.889	F-11	E8	168.969
F-14	C4	170.210	C-4	C6	102.112			
C-1	D4	102.112	F-9	D6	170.178			
C-2	E4	102.125	C-3	E6	101.978			
F-17	F4	169.111	F-7	F6	170.154			
F-1	C5	170.223	F-4	D7	170.206			

Total Mass Grams 2869.744

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

Table 2.

Use of Core Grid Plate Locations

Location	Hours
A-7	0.083
A-9	0.217
B-2	0.133
B-3	0.517
B-4	0.517
B-6	0.533
B-7	0.117
B-9	0.233
C-2	0.250
C-3	0.283
C-4	1.350
C-5	3.783
C-6	0.167
C-7	5.117
C-8	1.533
C-9	0.200
D-2	0.433
D-3	0.250
D-5	4.933
D-6	1.883
D-7	0.993
D-8	0.633
D-9	0.700
E-3	0.183
E-5	0.767
E-7	0.100
E-8	0.117
E-9	0.300
F-5	0.083
F-9	1.183
Total	27.591

Table 3.
Other Facilities

Facility	Hours
Bare Rabbit Tube	10.150
Beam Port	1.167
Reactor Console	1338.469
Thermal Column	0.167
Total	1349.953

Table 4

Reactor Utilization

Reactor use	(hr)	425.49
Research & Irradiation runs	(hr)	26.24
Instruction runs	(hr)	357.88
Maintenance runs	(hr)	41.37
Maintenance (reactor shutdown)	(hr)	1654.51
Time at power	(hr)	182.0
Heat generated	(kW·hr)	6299.98
Total number of samples		387.0
Sample hours	(hr)	45.05
Research & Instruction usage(1)	(1%)	18.5
U-235 burned	(g)	0.274
U-235 burned and converted	(g)	0.325

(1) Based on 2080 working hrs. per year.

Table 5

Scrams and Rundowns

Date	Event
4-13-83	120% Demand rundown Cause: Cover on linear recorder had been removed because of bad fastener. Corrective Action: Replaced cover and taped.
5-4-83	120% Demand rundown Cause: Void tube influencing linear CIC Corrective Action: Moved void
5-4-83	120% Demand rundown Cause: Void tube influencing linear CIC Corrective Action: Moved void
5-4-83	120% Demand rundown Cause: Void tube influencing linear CIC Corrective Action: Moved void
5-13-83	Scram Cause: Lightening caused momentary surge in power. Corrective Action: No corrective action necessary.
7-18-83	120% Demand rundown Cause: Moved fuel element too close to linear CIC. Corrective Action: None
7-18-83	120% Demand rundown Cause: Moved fuel element too close to linear CIC. Corrective Action: None
8-25-83	Scram Cause: MCA power being turned off and on caused fluctuation in regulated power. Corrective Action: None
9-2-83	120% Demand rundown Cause: Mismatch between linear and log N channels. Corrective Action: Corrected mismatch between linear and Log N channel.
10-3-83	Scram Cause: MCA power switched off and on. Corrective Action: None
10-4-83	Log N inoperative Scram Cause: Building power surge caused by Thunder storm in area. Corrective Action: None
10-11-83	Scram Cause: MCA power switched off and on. Corrective Action: None
10-19-83	120% Demand rundown Cause: Linear scale not switched. Corrective Action: SRO switched scales and terminated rundown.

Table 5, continued.

Date	Event
11-3-83	120% Demand rundown Cause: Operator error - Turned micro-micro ammeter scale wrong way. Corrective Action: None
11-15-83	120% Demand rundown Cause: Moving void tube in core. Corrective Action: None
11-18-83	120% Demand rundown Cause: Operator error - Turned micro-micro ammeter scale wrong way. Corrective Action: None
12-29-83	Scram Cause: Connected Log N signal cable. Corrective Action: SOP's for precheck and start-up checkout revised to give definite indication.

Table 6

Maintenance

Date	Event and Corrective Action
4-4-83	Adjusted Log N CIC as indicated by power calibration. (From 18 KW to 24 KW).
4-20-83	Replaced coax cable on fission chamber.
5-5-83	Replaced normal operate lamp in No. 1 and No. 3 RAM modules.
5-5-83	Replaced K 27 and K 28 behind console due to spurious rod drops that have occurred.
5-10-83	Replace V1, V2 and V3 (Magnet current power supply).
5-17-83	Replaced coax cable from fission chamber to preamp.
5-24-83	Removed conductivity meter for maintenance.
7-26-83	Replaced shim range switches. Replaced Reg. rod insert limit switch.
7-27-83	Replaced Reg. rod insert limit switch. Repaired bridge RAM module (detector).
7-29-83	Replaced shim range switch on No.1. Repaired switch activation device. Replaced spring on No.3 shim range switch.
9-7-83	Replaced Amphenol connector and cable to magnet No.3. Repaired short in connector to magnet No.3.
9-19-83	Rebuilt magnet No.3.
9-22-83	Repaired magnet No.3 Soldering flux caused magnet to short out.
9-26-83	Removed resistivity meter for maintenance.
11-2-83	Reinstalled resistivity meter.
11-3-83	Adjusted Log-N CIC to 50 KW as per power calibration.
12-6-83	Repaired No.3 shim range light by adjusting spring tension on switch.
12-7-83	Repaired RAM detector at demineralizer.
1-3-84	Replaced relay in demineralizer resistivity meter. Removed and replaced power wires for demineralizer.
1-15-84	Repaired door alarm sensors.
3-2-84	Replaced spring on No.3 shim range switch.

Table 7.

Core Loading and Unloading

Date	
7-18-83	Unloading core to subcritical for purpose of inspecting the control rods.
7-19-83	Loading core to the previous configuration (67W).

B. Core Data

During this reporting period only one core designation has been used. The "W" mode core was used for normal reactor operations, since students are not supposed to operate the reactor when the excess reactivity is above 0.7%. The "T" mode is used for extended operation (>3 hrs), or beam port or 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	10-10-83
I 2.64%	II 2.65%	III 3.36%	Reg. 0.347%

Excess Reactivity (in "T" mode) 0.92% Shutdown Margin (in "T" mode) 4.37%.

Void Coefficient -6.6×10^{-7} ρ/cm^3 Date 11-16-83 Limit -2.0×10^{-7} ρ/cm^3

Temperature Coefficient -1.3×10^{-4} ρ/°F Date 12-15-83 Limit -4.0×10^{-5} ρ/°F

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

I 0.019 II 0.019 III 0.026 Reg. 0.01

Rod Drop Time (24")

I 470 msec, II 460 msec, III 480 msec, Date 1-4-83

Magnet Separation Time (at I_{max})

I 38 msec, II 30 msec, III 26 msec, Date 1-4-83

VI. Public Relations

The reactor staff continues to put forth considerable effort to help educate the public about the application of nuclear energy. Over 2,969 persons have toured the facility during this report period. This is an increase of 36% when compared to the last reporting period. Tours included groups representing social, military, civic, industrial, governmental and educational fields. These groups are usually given a brief orientation lecture by a member of the reactor staff. These lectures are augmented by visual aids such as slides and displays. Many high school, junior college and college groups have attended the various lectures and open houses.

Some other groups have 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. A guided tour by the reactor staff includes a brief description of the basic nuclear reactions, components of a nuclear reactor, a few specific examples of how nuclear energy is used in the industrial and educational fields and how nuclear energy helps the environmental situation.

Posters to display for the public capabilities and uses of the UMRR have been made and installed in the reactor bay area. Two staff members participated in the International Symposium on the Use and Development of Low and Medium Flux Research Reactors presenting two papers about the facility's achievements and programs.

The Nuclear Engineering faculty are members of various social civic,

professional, and governmental committees. The faculty and students also are involved in speaking engagements around Missouri concerning the reactor facility and in informational programs at high schools and colleges.

VII. Educational Utilization

Approximately 30 UMR students, graduates and undergraduates, have participated in classes at the facility, utilizing 48 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.

NE 204 Nuclear Radiation Measurements	3.9
NE 304 Reactor Laboratory I	70.83
NE 306 Reactor Operations	194.98
NE 308 Reactor Laboratory II	39.0
NRF-4 Reactor Operator Training	49.17
Preliminary Research	26.24

The current enrollment in Nuclear Engineering is 73 students. During this reporting period the reactor was used 84.1% for instruction, 6.2% for research, and 9.7% for maintenance.

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. About 101 students and their instructors participated in this program.

VIII. 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.

Routine Surveys

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.

By-Product Material Release Surveys

During the period, 2 shipments of by-product material were surveyed and released from the reactor facility. Total activity released was 0.581 mCi. The shipments were utilized on the UMR Campus.

Routine Monitoring

Twenty-three 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 area badges assigned and one test badge to check accuracy of exposure reports. Fourteen 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 13 beta-gamma area and spare badges assigned on campus. In addition, 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. Rb-88 and Cs-138 are the particulate daughters of Kr-88 and Xe-138 which are particulate activity monitored above the natural background of radon daughter products.

Argon-41, Krypton-88 and Xenon-138 are the gaseous activity routinely detected during operations.

Pool water activity is monitored monthly to insure 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 2.73×10^{-6} µCi/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 6.07 millicuries were released into the air. Released isotopes were identified as Kr-88, Rb-88, Xe-138, Cs-138 and 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 11 releases to the sanitary

sewer totaling approximately 8,985 gallons of concentrated resin regeneration solution and pool water were discharged with a total activity of 0.581 millicuries. Isotopes released were: Hydrogen-3, Sodium-24, Cr-51, Mn-54, Fe-59, Co-58, Co-60, La-140, and Ba-140. All isotopes released were below 10 CFR 20, Appendix B, Table I, Column 2 limits.

Instrument Calibrations

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

IX. Plans

Presuming that the re-licensing process, which is presently underway, will be completed and that continued operation of the reactor will be approved by the U.S. NRC, the reactor management would like to spend a lot more time and effort upgrading the facility's research capability. Although extra efforts have been made to inform academic department chairmen and research center directors of the current availability of the reactor and the various associated counting systems, we have not generated very much research activity. We also try to inform the individual faculty members/researchers, who we believe might be doing research that could utilize the UMR Reactor, that we would be pleased to cooperate with them.

In particular, it would enhance the neutron activation analysis capability of the UMR Reactor Facility if the present pneumatic transfer system were to be modified so that samples could be transferred directly from the core to the Ge(Li) detector. Likewise, it would be beneficial to have an automatic sample handling system so that a large number of samples (say at least 24 of them) could be inserted into the Ge(Li) detector and counted. We would also like to develop prompt neutron activation analysis capabilities. The hardware necessary for the suggested improvements would be requested on research proposals prepared by the reactor staff or in cooperation with other researchers.

Last year we indicated that we had submitted a proposal to the U.S. Department of Energy for support in the University Reactor Sharing Program. We were selected for $9000 financial support. To date four separate groups from Linn Technical Institute have come to campus for a day each. The University of Arkansas will send 10 graduate students for two days in April.

Other schools are expected to use the reactor for education or research before the end of the contract in August. We hope to be selected for an extension of that program.

Last year's plan to have at least three licensed senior operators has been accomplished. The two current reactor operators are planning to take the senior operator's examination early this coming reporting period. Two Electrical Engineering students, who served as operators in U.S. Navy nuclear submarines and who have satisfactorily completed our student reactor operator training program, have expressed an interest in taking the NRC reactor operator's examination. If all of these individuals pass their examinations, we would be very well staffed next year.

In terms of modifications to the facility which are planned, they include several which have been mentioned in prior Progress Reports. We do plan to install the new solid-state magnet power supply and solid-state power range (safety) channels that were purchased several years ago and not installed because we were in the midst of re-licensing. The Technical Specifications and Final Safety Analysis Report will incorporate descriptions of the new systems. Without a doubt, the solid-state devices should be more reliable than the present vacuum tube ones, which were original equipment.

Following discussions with the NRC licensing representatives, we feel that pursuit of operating with a mixed core of MTR-type and TRIGA-type fuel is insurmountable. A complete conversion to TRIGA fuel apparently would involve a complete relicensing of the facility, including the construction permit stage. Thus, we have decided not to attempt such a changeover of fuel.

APPENDICES

APPENDIX A

UNIVERSITY OF MISSOURI

Research Reactor Facility

Research Park
Columbia, Missouri 65211
Telephone (314) 882-4211

February 24, 1984

Dr. Albert Bolon
Reactor Director
University of Missouri-Rolla
Nuclear Engineering, Building C
Rolla, Missouri 65401

Dear Dr. Bolon:

On Tuesday, January 10, 1984, Barry Bezenek and I conducted a Reactor Facility Inspection of the UMR-Reactor. This inspection concentrated on just a few of the areas given in your inspection form. The detailed comments from the inspection are primarily contained in this letter with the inspection form attached indicating both the few areas reviewed in detail and those briefly scanned.

The Operator Requalification Program records were reviewed in detail. Improvements should be made in the documenting of Nuclear Instrumentation checks, review of changes to Standard Operating Procedures, and Abnormal and Emergency procedure reviews. One page of the 1982 requalification documentation for an operator was missing. UMRR may want to consider removing the completed requalification sheets at the end of each year, instead of leaving them mixed in with the new working documents. This may reduce the potential of them being accidentally lost.

The Health Physics records were reviewed in detail and were found to be well maintained. However, two changes to current practices are recommended. Radiation and swipe surveys should be conducted in the upstairs offices. This could be performed infrequently but should be done since these areas are manned during reactor operations, and personnel eat and drink in the offices.

Secondly, you may want to consider revising the method of calculating the monthly air release. Your current method makes the amount of Ar-41 released heavily dependent on which fan is in operation. The difference in flow rate between the fans should primarily affect the equilibrium concentration value in the building and only slightly affect the release rate. The lower the flow rate the slightly less Ar-41 is released due to the longer holdup time allowing more to decay before being released.

$$\frac{dN}{dt} = \text{Production - Removal}$$

$$= P - \lambda N - \frac{F.R.}{Vol} N$$

N = # of atoms of Ar-41 per unit volume in atoms/ml

P = # of atoms Ar-41 released per minute divided by total building volume in $\frac{\text{atoms}}{\text{ml-min}}$

λ = Decay constant for Ar-41 = $6.3 \times 10^{-3}\ \text{min}^{-1}$

F.R. = Flow Rate for designated fan in cfm.

Vol = Building Volume in ft^3 ~ $4.455 \times 10^4\ ft^3$

In equilibrium $\frac{dN}{dt} = 0$

$$P = \left(\lambda + \frac{F.R.}{Vol}\right) N$$

$$N = \frac{P}{\lambda + \frac{F.R.}{Vol}}$$

Using this relationship the following table can be constructed for equilibrium values.

Fan	1 or 2	3	No Fans
F.R.	15,000 cfm	5,000 cfm	0
F.R./Vol	$3.367 \times 10^{-1}\ \text{min}^{-1}$	1.122 z $10^{-1}\ \text{min}^{-1}$	0
N $\left(\frac{\text{atoms}}{\text{ml}}\right)$	2.915P	8.436P	158.7P
Release Rate $\left(\frac{\text{atoms}}{\text{min}}\right)$	$1.238 \times 10^9 P$	$1.194 \times 10^9 P$	0

This assumes constant release rate to the building atmosphere. A test would have to be run to determine P for typical pool condition*) This could be done with no fans on and plotting the buildup of activity in the building.

*) According to this, we would have to establish the relationship
P = Function (Reactor power Q)
which would be an interesting project by the way!
N. Ca[illegible]

The console logs, Startup Checkout sheets, and Shutdown Checkout sheets were reviewed in detail. The log book accuracy had made good improvement compared to that observed in December 1982 audit. The following recommendations are based on this part of the review.

a) On July 13, 1983, a Startup Checkout sheet was not used for a startup immediately following a shutdown in which the Shutdown Checkout sheet was completed. This is allowed by SOP 102 due to the phase "... unless otherwise specified by the Senior Operator on duty." You may want to more clearly define the Senior Operator's discretion in this situation; i.e. require him to do at least the steps that return equipment to operation that were secured while completing the Shutdown Checkout sheet.

b) Suggest it would be beneficial to log when a control rod is removed and when it is reinstalled during the inspection of control rods.

c) It was noted a Startup Checkout sheet was completed by procedure prior to raising the control rod to 50% for refueling during the control rod inspection procedure, but was not done prior to raising the rods for refueling. This looks inconsistent in our superficial review but may be quite justifiable if reviewed in detail, therefore this observation is stated for your consideration.

d) The UMRR staff should evaluate how they will document their decisions to operate with instrumentation/equipment inoperable, i.e. Rod Magnet Contact Indication, Rod Prohibit, etc.

e) Recommend any time a safety system component is discovered inoperable that the reactor be immediately shutdown then try to correct the problem.

f) Recommend modification reviews be completed on any change to a reactor related system prior to making the change, such as the antisiphon change to the pool system.

We found the operations being conducted in a satisfactory manner with no significant problem areas identified.

Sincerely,

Charlie McKibben

J. C. McKibben
Reactor Manager

JCMK:vs

Attachment: Inspection Form

cc: Ray Bono

REACTOR FACILITY INSPECTION -- Date(s) Jan 10, 1984
(Phone: 341-4236)

Date(s) of last NRC inspection September 13-16, 1983

Date(s) of last "inhouse" inspection May 16 & 17, 1983

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	VI	12	5/12/83
Through entry:	VI	81	1/9/84

Follow up items from previous inspection (item, follow-up):

Log book accuracy

Revision to S.O.P.

	OK	Comment
A. Technical specifications ------------- Appendix A -- Jan. 6, 1967	✓	
1. (2.1) Ventilating fans ----------- Automatic closure ---------------		
2. (3.1) Pool water depth (16 ft. min above core) -----------------	✓	
3. (3.1) Inlet water temperature 60°F <t <135°F ------------------	✓	
4. (3.2) Radiation one meter above pool <5 mr/hr -----------------	✓	
5. (3.2) Resistivity >0.5 megohm-cm-	✓	
6. Fuel ----------------------------		Type of elements: MTR Other ______
(4.1.3) ρ ex <1.5% --------------		Present loading(s):
1.5% <ρex<3.5% five consecutive days twice a year -----------------	N/A	Dates: (1)______ (2)______
7. Control rod: (9.5) condition -----		Date Inspected:
(4.2.3) Reactivity shutdown margin at least 8% --------------		
(4.2.4) Drop time <600 msec -------		(9.3) Dates: (1)______
(4.3.2) Limit lights; shim range lights, magnet contact lights -----		(2)______
8. Neutron source (min. 10^6 n/sec ----		

	OK	Comments
9. Safety systems (annunciator)------		
(5.4) Start-up channel------------	✓	
(5.4) Linear channel-------------	✓	
(5.4) Log N - Period channel------	✓	
(5.4) Safety channel #1-----------	✓	
(5.4) Safety channel #2-----------	✓	
10. (5.5) Magnet release time <50 msec		
11. (5.7) Radiation levels <0.1 mr/hr		Location / Reading
		Pool surface above core
		Near demineralizer
		Beam room
12. (5.8) Portable survey instruments List:		
Neutron		Alpha
Gamma		Beta
Other		
13. Experimental facilities----------		Give example as to how it is used.
Hung samples---------------------		Greatly improved the documentation on Experiments now the on duty operator should be able to easily identify an experiment is approved and then document which experiment was run.
(6.1.1) Core access element-------		
(6.1.1) Isotope prod. element-----		
(6.1.2) Rabbit tube---------------		
(6.1.2) Thermal column------------		
(6.1.2 Beam port-----------------		
(6.2.2) Documentation of exps.----		
(6.2.3) Single independent experiment: ρ_{ex} <0.7% -------------		
(6.2.4) Single movable experiment: ρ_{ex} <0.4% -------------		
0.6% all movable exp.---		
(6.2.5) Experiments having moving parts: ρ_{ex} <0.05%-------------		
(6.2.6) Position of any/all exp.--		
14. General Operating Limitations		
(7.1) Startup: Sr. Oper. plus one (in the control room)		
(7.1) Operation: S.O. plus one--- (in building)		
(7.4) No fuel position vacancies in core; loading (wall chart)-----		

	OK	Comments
15. Fuel Storage & Transfer wall chart -----------------------		
(8.3) Fuel handling tools locked--		
(8.4) Fuel transfer--three men (Sr.Oper.; Lic.Oper.; plus one----	✓	
16. (10.1) New loading: approach to critical exp.(reason & date)------		
(10.2) Core configuration change: one grid position. (Reason & date)		
(10.3) Loading change of more than one grid position-unload 50%------		
17. Instruments functioning (Table I)-	✓	(On weekly check list - *)
Scram: Manual---------------------	✓	startup
Period <5 sec.-------------	✓	*
150% full power-----------	✓	startup
Bridge motion-------------	✓	*
Log N- Period non-op------	✓	*startup
Rundown: 120% power (linear)-----	✓	*
Period <15 sec -----------	✓	*
Reg Rod (insert limit-auto rundown)	✓	
120% full power (log N)---	✓	*
Low CIC voltage-----------	✓	startup
High radiation------------	✓	startup
Rod prohibit: Period <30 sec-----	✓	*
Any recorder off----------	✓	*
Low count rate------------	✓	*
Reg Rod prohibit (rods below shim range)---------	X	← 2 not always functioning on Startups
Inlet temp.> 135°F--------	✓	*
Servo-prohibit on reg. rod--------	✓	
18. Check Lists and records	✓	
Log book checked------------------	✓	
(9.1) Daily facility check list---		
(9.3) Instrument channels & area monitors-calibrated at 90 day intervals----------------------	✓	Dates: (1)________ (2)________ (3)________ (4)________
UMRR startup check list-----------	✓	
Hourly records-note variations----	✓	← 2 not always completed weekly but definite improvement was noted starting in October 1983.
Shut-down check list--------------	✓	
Weekly check list-----------------	✓	
Work load log---------------------	✓	
Six month systems check-----------	✓	Dates: (1)________ (2)________

	OK	Comments
B. Records		
1. Log books----------------------	✓	Current book number VI Other ____ Stored ____
2. Recorder charts---------------	✓	Stored: where and for how long
Log N (permanent)-------------	✓	Located:
3. Evacuation alarms: number and cause------------------------	✓	1. 5/15/83 2. 11/17/83, 12/15/83
4. Evacuation procedures, drills-	✓	
5. Use of by-pass keys-----------		1. 1/4/84
6. Key security------------------		
General security--------------		
Night use of building---------		
7. SOP'S - Note any revisions----	✓	Several revisions have been made since the last MUFF inspection
8. Film badge, dosimeter---------		
9. Night watchman record---------		
C. Reactor Bay		
1. General condition of pool-----	✓	
2. General condition of storage--	✓	
3. Use of cable trench-----------	✓	
4. Nitrogen diffuser-------------	✓	
5. Miscellaneous (List)----------		
D. Control Room-------------------		
List of current operators----------	✓	Senior operators: Albert Bolon April 6, 1982 Dan Carter Sept 9, 1983 C. M. Barton Sept 9, 1983
E. Office (film badge rack, etc.)-----		
F. Counting Room--------------------		Operators:
G. Rooms & Storage upstairs----------		Karen G. Lane May 4, 1983 Milan Straka Sept 22, 1983

	OK	Comments
H. Stairwell & pump area	✓	
1. Demineralizer system		
2. Outside air filters		
I. Stairs and beam room	✓	
1. Thermal column	✓	
2. Beam tube	✓	
3. Fuel storage		
4. Liquid & solid waste storage		
J. Health Physics		
1. Sample removal	✓	
2. SOP'S (list)	N/A	
3. Excursion or incident monitor		
a. Film badge placement	✓	
b. Other	✓	
4. Film badge, dosimeter records	✓	
a. Staff	✓	
b. Students	✓	
c. Guests	✓	
d. Night watchman	✓	
5. Possible detection of fuel element rupture	✓	
6. Radiation survey	✓	Dates:
a. Periodic swipe tests	✓	
b. Pool water	✓	
c. Inside air	✓	
d. Outside air	✓	— not done outside
e. Neutron level (sub-critical)	✓	part of survey
f. Misc. items (list)	✓	
g pool H-3	✓	
7. Emergency box (Physics Bldg.)	✓	discussed but did not look at

General comments:

See cover letter.

J C McKibben

May 11, 19 (Start-up)

REACTOR FACILITY INSPECTION -- Date(s) May 16 & 17, 1983
(Phone: 341-4236)

Date(s) of last NRC inspection Safeguards Oct 20-22, 1982

Date(s) of last "inhouse" inspection Dec. 15, 1982

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	V	268	Dec 16, 1982
Through entry:	VI	12	May 13, 1983

Follow up items from previous inspection (item; follow-up):

	OK	Comments
A. Technical specifications ------------- Appendix A -- Jan. 6, 1967	✓	Changes None, if so, list
1. (2.1) Ventilating fans ------------	✓	
Automatic closure ----------------	✓	
2. (3.1) Pool water depth (16 ft. min above core) ----------------------	✓	
3. (3.1) Inlet water temperature $60^{\circ}F < t < 135^{\circ}F$ ----------------	✓	
4. (3.2) Radiation one meter above pool < 5 mr/hr ----------------	✓	
5. (3.2) Resistivity > 0.5 megohm-cm-	✓	
6. Fuel -----------------------------	✓	Type of elements: MTR Other Irsa (Beam Port) Present loading(s): 67W & 67T
(4.1.3) $\rho_{ex} < 1.5\%$ -------------- (See Bk V p. 73-275)	NA	Sr. Oper.
$1.5\% < \rho_{ex} < 3.5\%$ five consecutive days twice a year --------------	NA	Dates: (1) ______ (2) ______
7. Control rod: (9.5) condition -----	✓	Date inspected: July 15, 1982 Rods ok BK V p 2
(4.2.3) Reactivity shutdown margin at least 8% --------------	✓	
(4.2.4) Drop time < 600 msec ------	✓	(9.3) Dates: (1) Dec 20, 1982 (2) ______
(4.3.2) Limit lights; scram range lights; magnet contact lights -----	✓	one not operative - procedure OK - #2 shim rod
8. Neutron source (min. 10[?] n/sec) ---	✓	

	OK	Comments
9. Safety systems (annunciator) ------	✓	
(5.4) Start-up channel -------------	✓	
(5.4) Linear channel --------------	✓	
(5.4) Log N - Peroid channel ------	✓	
(5.4) Safety channel #1 -----------	✓	
(5.4) Safety channel #2 -----------	✓	
10. (5.5) Magnet release time < 50 msec	✓	
11. (5.7) Radiation levels < 0.1 mr/hr-	✓	Location / Reading Pool surface above core ------------ OK [illegible] Near demineralizer - [illegible] Beam room ---------- [illegible]
12. (5.8) Portable survey instruments - List: Neutron Gamma Other ~~See attached sheet~~ See note book at the reactor building		Alpha Beta
13. Experimental facilities -----------	✓	Give example as to how used.
Hung samples ---------------------	✓	
(6.1.1) Core access element --------	✓	
(6.1.1) Isotope prod. element -----	✓	
(6.1.2) Rabbit tube ---------------	✓	
(6.1.2) Thermal column ------------	✓	
(6.1.2) Beam port -----------------	✓	
(6.2.2) Documentation of exps. ----	✓	
(6.2.3) Single independent experiment: $\rho_{ex} < 0.7\%$ -------------	✓	
(6.2.4) Single movable experiment: $\rho_{ex} < 0.4\%$ -------------	✓	
0.6% all movable exp. ------	✓	
(6.2.5) Experiments having moving parts: $\rho_{ex} < 0.05\%$ -------------	✓	
(6.2.6) Position of any/all exp. --	✓	
14. General Operating Limitations		
(7.1) Startup: Sr.Oper. plus one (in the control room)	✓	
(7.1) Operation: S.O. plus one (in building)	✓	
(7.4) No fuel position vacancies in core; loading (wall chart) ----	✓	

	OK	Comments
15. Fuel Storage & Transfer wall chart ----------------------	✓	also checked fuel inventory dated April 15, 1983
(8.3) Fuel handling tools locked --	✓	
(8.4) Fuel transfer--three men (Sr. Oper.; Lic. Oper.; plus one --	✓	
16. (10.1) New loading: approach to critical exp. (reason & date)------	✓	None —
(10.2) Core configuration change: one grid position. (Reason & date)-	✓	Bk V p 280 — Feb 23, 1983 OK
(10.3) Loading change of more than one grid position-unload 50% ------	✓	
17. Instruments functioning (Table I)--	✓	(On weekly check list - *)
Scram: Manual -------------------	✓	startup
Period < 5 sec. -------------	✓	*
150% full power -------------	✓	startup
Bridge motion ---------------	✓	*
Log N - Period non-op ------	✓	*startup
Rundown: 120% power (linear) ------	✓	*
Period < 15 sec ------------	✓	*
Reg Rod (insert limit-auto rundown) ----------------	✓	*
120% full power (log N) ---	✓	*
Low CIC voltage ------------	✓	startup
High radiation -------------	✓	startup
Rod prohibit: Period < 30 sec. --	✓	*
Any recorder off ----------	✓	*
Low count rate ------------	✓	*
Reg Rod prohibit (rods below shim range) ---------	✓	
Inlet temp. > 135°F -------	✓	*
Servo-prohibit on reg. rod ----------	✓	.
18. Check Lists and records		
Log book checked ------------------	✓	
(9.1) Daily facility check list --	✓	
(9.3) Instrument channels & area monitors-calibrated at 90 day interval. ------------------------	✓	Dates: (1) Ram {Dec 30, 1983; Mar 30, 1983} Handheld {(2) Feb 1983; (3) Nov 24, 1983} (4) ______
UMRR startup check list -----------	✓	
Hourly records-note variations ---	✓	
Shut-down check list ------------	✓	
Weekly check list ---------------	✓	
Work log log ----------------------	N.A	
Six month systems check ----------	✓	Dates: (1) Jan 10, 1983 (2) Feb 11, 1983 power calibration — started but has not been completed as of May 16, 1983

	OK	Comments
B. Records		
1. Log books ----------------------	✓	Current book number VI Other ✓ Stored safe in control room
2. Recorder charts ----------------	✓	Stored: where and for how long
Log N (permanent) ---------------	✓	Located: In building
3. Evacuation alarms: number and cause -------------------------	✓	1. Nov 30, 1982 Cu-wire removed too close to Bridge Ram 2. —
4. Evacuation procedures, drills --	✓	— Feb 18, 1983
5. Use of by-pass keys ------------	✓	1. Jan 27, 1983 T<30 sec 2. Feb 1, 1983 T<30 sec
6. Key security -------------------	✓	
General security ---------------	✓	
Night use of building ----------	✓	
7. SOP'S - Note any revisions ----- Some have been made	✓	
8. Film badge, dosimeter ----------	✓	
9. Night watchman record ----------	✓	
C. Reactor Bay		
1. General condition of pool ------	✓	
2. General condition of storage ---	✓	
3. Use of cable trench ------------	✓	
4. Nitrogen diffuser --------------	✓	
5. Miscellaneous (List) -----------	✓	None
D. Control Room ------------------------	✓	
List of current operators ----------	✓	Senior operators: A. E. Bolon — April 6, 1982 Operators: ESB Karen G. Lane — May 4, 1983 Carl M. Barston - Oct 14, 1982 Daniel Carter — Apr. 6, 1982
E. Office (film badge rack, etc.) ----	✓	
F. Counting Room -----------------------	✓	
G. Rooms & Storage upstairs ----------	✓	

	OK	Comments
H. Stairwell & pump area	✓	
1. Demineralizer system	✓	
2. Outside air filters	✓	
I. Stairs and beam room	✓	Floor is wet — building leaks
1. Thermal column	✓	
2. Beam tube	✓	
3. Fuel storage	✓	
4. Liquid & solid waste storage	✓	
J. Health Physics		
1. Sample removal	✓	
2. SOP'S (list)	✓	
3. Excursion or incident monitor	✓	no changes
a. Film badge placement	✓	
b. Other	✓	
4. Film badge, dosimeter records	✓	
a. Staff	✓	
b. Students	✓	
c. Guests	✓	
d. Night watchman	✓	
5. Possible detection of fuel element rupture	✓	— high radiation would detect
6. Radiation survey	✓	Dates: 11/30/82, 12/29/82 1/31/83, 2/28/83, 3/31, 4/29
a. Periodic swipe tests	✓	
b. Pool water	OK	
c. Inside air	✓	
d. Outside air	N.A.	
e. Neutron level (sub-critical	N.A.	
f. Misc. items (list)	✓	
(6 months) Pool H2O Tritium sample	✓	— fairly new
7. Emergency box (Physics Bldg.)	✓	Clean & checked

General comments: The overall operation of the reactor facility is excellent. In this I would include reactor start-up, record keepint and availability of records, house-keeping, professional attitude of the staff, etc.

I would like to make several comments. These have been discussed with appropriate staff members.

1) Lately there have been more than the usual "spurious" rundowns and/or scrams. Remedial measures are in progress and it may very will be that the summer maintenance program will take care of the problem. I think that in the fall special attention should be given as to whether they still occur. I don't see that they, in any way, endanger the safe operation of the reactor but they are a nuisance.

(2) The semi-annual check and report was started Jan. 10, 1983 but at this date (May 16, 1983) has not been completed. This needs to reviewed in the Fall 1983 independent audit.

(3) One week the weekly check was not made but a sheet inserted at the appropriate week explained why not--excellent procedure.
(4) The Daily Facility check was not done in the usual manner, nor recorded, during the week of May 9. (J. Williams who usually does this was on vacation.) Someone should have been assigned to make the check.
(5) I'm somewhat disturbed in that the basement floor is wet. I understand the building leaks.

Health physics records are in good order. Ray Bonon seems to be "on top of things".

Signed: Franklin B. Pauls

Copy to:
Dr. A. E. Bolon
Nuclear Reactor Facility

Dr. N. L. Nord
Chairman, Radiation and Safety Committee
G-3 Chem

Special Nuclear Material (SNM)

Position Name

Reactor Director Dr Bolon

Reactor ~~Supervisor~~ Manager Straka

SNM Custodian ~~Dan~~ Carter

1. (See p. 2) Procedures reviewed annually by the Reactor Supervisor:

   Date: Dec 8, 1982 — Name: A.E. Bolon

2. SNM Records: Where kept? File cabinet - main office

   (1) Position and/or change of position of non-irradiated fuel: None

   (2) Position and/or change of position of irradiated fuel: None

   (3) SNM receipts: 8 gm Enriched Uranium rod Feb 2, 1983

   (4) SNM shipments: None

   (5) Semi-annual Material Status Report:
   Most recent previous report: Date Sept 30, 1982
   Current report:
   Date April 15, 1983

   (6) Annual Physical Inventory (SNM status log): OK
   Date
   Previous report: Sept 30, 1982

   Current report: April 15, 1983

   (7) SNM loss, theft or sabotage reported: None
   Date To whom reported (Director Region III NRC)

   (8) (See p. 5) Violations of Written Procedures: None

   (9) SNM Internal Control Areas: ✓

   Dry storage area (basement): OK

   Reactor: OK

   Containment building: OK

Operator Requalification During License Period

A. Examination Review Sheet (Annual exam -- usually in summer)

Name of Operator	License number and date	Exam dates	Comments	5-year record
1. A. E. Bolon	SOP-30022 April 6, 1982	Made out test - didn't take		
2. K. Lane	OP-5473-1 May 4, 1983	May 28, 1982 Dec 6, 1982		
3. C. Barton	OP-30089 Oct 14, 1982	May 28, 1982		
4. D. Carter	OP-30044 April 6, 1982	May 28, 1982 July 29, 1982		

B. Performance Evaluation (Semi-annual)

Name of Operator	Evaluation Date	Comments
1. A. E. Bolon	?	
2. K. Lane	Dec 7, 1982	OK
3. C. Barton	Dec 21, 1982	OK
4. D. Carter	Dec 2, 1982	OK

C. On the Job Training: Progress Report (Annual Summary) (Notebook kept by the operator.)

Name of Operator	Annual Summary Date	Comments
1. Bolon	Sep - 1982	—
2. Lane		
3. Barton	?	
4. Carter		

Milan Straka — new

APPENDIX B

Semi Annual Check List

Date Commenced DEC 1983

Date Completed ~~5 DEC 1983~~ Jan 6 1984

Total Hours on Hour Meter [illegible]

1. Vacuum Tube Test and Clean Chassis — Initial

   a. Log N Power Supply

      (1) Cleaned chassis Date DEC 1 1983 [illegible]

      (2) Tested all vacuum tubes [illegible]

      Replaced:

tube #	tube type
None	

      (3) Additional Comments

   b. Linear Power Supply Date

      (1) Cleaned chassis [illegible]

      (2) Tested all vacuum tubes [illegible]

      Replaced:

tube #	tube type
None	

      (3) Additional Comments

c. Safety Amplifier Date DEC 1 [illegible]

(1) Cleaned chassis [illegible]

(2) Tested all vacuum tubes [illegible]

Replaced: tube # tube type

(3) Additional Comments

d. Area Radiation Monitor Date [illegible]

(1) Cleaned chassis [illegible]

(2) Additional Comments

e. Micro-Micro Ammeter Date [illegible]

(1) Cleaned chassis [illegible]

(2) Tested all vacuum tubes [illegible]

Replaced: tube # tube type

(3) Additional Comments

f. Fission Preamp Date DEC 1 [illegible]

(1) Cleaned chassis and inspected [illegible]

(2) Additional Comments

g. Public Address System Date [illegible]

(1) Cleaned chassis ________

(2) Additional Comments

h. Log Count Rate Recorder Date DEC [illegible] 1983

(1) Cleaned chassis ________

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

i. Linear Recorder Date [illegible]

(1) Cleaned chassis ________

(2) Tested all vacuum tubes ________

Replaced:

tube #	tube type
None	

(3) Additional Comments

j. Period Recorder Date DEC [illegible] 1983

(1) Cleaned chassis ________

(2) Tested all vacuum tubes ________

Replaced:

tube #	tube type
None	

(3) Additional Comments

k. Log N Recorder Date DEC 1 1983 CMB

(1) Cleaned chassis CMB

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

l. PAT 60 Date DEC 1983 CMB

(1) Cleaned chassis CMB

(2) Tested all vacuum tybes

Replaced:

tube #	tube type
None	

(3) Additional Comments

m. Safety Amp Preamp Date DEC CMB

(1) Cleaned chassis CMB

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

n. Regulated Power Supply   Date DEC 1_ 198_   [initials]

(1) Cleaned chassis

(2) Additional Comments

o. Conductivity Bridge   Date DEC _ 19__   [initials]

(1) Cleaned chassis

(2) Additional Comments

2. Relay Test   Date DEC _ _ 198_

a. Console relays tested and replaced as per SOP 815 [initials]

b. Additional Comments No relays were replaced

3. Detector Resistance   Date JAN _ 1984

a. Safety #1   Value

		Value	Initial
(1)	Signal to ground	[illegible]	[initials]
(2)	Positive to ground	4.5 x 10^12	[initials, struck through]
(3)	Additional Comments		

b. Safety #2

		Value	Initial
(1)	Signal to ground	~~[illegible]~~ 1 x 10^12 [illegible]	[initials]
(2)	Positive to ground	[illegible]	[initials]
(3)	Additional Comments		

c. Log N

(1) Signal to ground	9 X 10^12	CMB
(2) Positive to ground	7.2 X 10^13	CMB
(3) Negative to ground	2.7 X 10^13	CMB
(4) Additional Comments		

d. Linear

(1) Signal to ground	3 x 10^13	CMB
(2) Positive to ground	3.1 X 10^13	CMB
(3) Negative to ground	1.4 X 10^13	CMB
(4) Additional Comments		

4. Calibration Checks

Note: Any instrument found to be out of calibration should be realigned in accordance with its technical manual.

A. Temperature Recorder Date JAN 6 1984

1.

Reading #	Thermometer	Recorder
1	80°F	80°F
2	80°F	80°F
3	80°F	~~8~~ 79°F
1	140°F	140°F
2	140°F	140°F
3	140°F	140°F

Note: All readings should be ± 1°F

2. 135°F Interlock	Trip Point	Initial
	134	CMB

B. Log Count Rate Channel   Date DEC 2 . 1983

1.

Pulse Generator*	Meter	Recorder	Initial
10	10	11	CWMB
100	98	100	CWMB
1000	1000	1000	CWMB
10,000	10000	10000	CWMB

Note: All readings should give .7 to 1.4 ratio of true-to observed readings.

2. Additional Comments

C. Linear   Date DEC 2 8 1983

1.

Keithley	Meter	Recorder	Initial
$6.66X10^{-5}$	6.60	100%	CWMB
$2.0X10^{-5}$	2.0	100%	CWMB
$6.66X10^{-6}$	6.7	101%	CWMB
$2.0X10^{-6}$	2.0	100%	CWMB
$6.66X10^{-7}$	6.8	102%	CWMB
$2.0X10^{-7}$	6.8	101%	CWMB
$6.66X10^{-8}$	6.60	100%	CWMB
$2.0X10^{-8}$	2.0	101%	CWMB
$6.66X10^{-9}$	6.70	101%	CWMB
$2.0X10^{-9}$	2.0	100%	CWMB
$6.66X10^{-10}$	6.60 X10 [illegible]	100%	CWMB
$2.0X10^{-10}$	2.0 X10 [illegible]	98%	CWMB

Note: From 10^{-3} to 10^{-8} the overall accuracy should be better than 2% of full scale.

From $3X10^{-9}$ to $3X10^{-13}$ the overall accuracy should be better than 4%.

2. Additional Comments

installed SN19650 — Removed 19 S.N. 19683

D. Log N — Date DEC [illegible] 1985

1.

Meter	Recorder	Keithley	Initial
100	100	[illegible]	[illegible]
10	10	3.5×10^{-6}	[illegible]
1	1	[illegible]	[illegible]
0.1	0.1	[illegible]	[illegible]
.01	0.01	6.5×10^{-9}	[illegible]
.001	0.001	10×10^{-10}	[illegible]
.0001	0.0001	10×10^{-11}	[illegible]

Note: The ratio of true-to-observed readings should be between 0.7 and 1.4.

2. Additional Comments

5. Rod Indicator Calibration

DEC [illegible]

Actual Height	I.	II.	III.	Reg.
		Indicator Reading		
1"	1	[illegible]	[illegible]	[illegible]
6"	[illegible]	[illegible]	[illegible]	[illegible]
12"	[illegible]	[illegible]	[illegible]	[illegible]
18"	[illegible]	[illegible]	[illegible]	[illegible]
24"	[illegible]	[illegible]	[illegible]	[illegible]

6. Fire Alarm Check — Date JAN 1[illegible] 19[illegible]
   a. Cleaned system containers ____
   b. Changed Batteries ____
   c. Checked pull stations ____
   d. Checked heat detectors ____
   e. Checked smoke detectors ____
   f. All indicator lamps operate ____

7. Security System Check — Date JAN [illegible]
   a. Door Sensors ____
   b. Motion Detectors ____
   c. Duress Alarm ____
   d. Control Modules — Date J[illegible]
      (a) Power Supply (at UMR Police office)
      (b) Control Module

[illegible]

Date 23 March 19 84

I have reviewed the results of this Semi-Annual Check on this date and discussed any problems and/or errors with the operating staff.

Director or Reactor Manager

_________________ _________________

Semi Annual Check List

Date Commenced JUL 25 1983

Date Completed OCT 31 1983

Total Hours on Hour Meter 8449.4

1. Vacuum Tube Test and Clean Chassis — Initial

   a. Log N Power Supply — JUL 25 1983

      (1) Cleaned chassis — C.MB

      (2) Tested all vacuum tubes — C.MB

      Replaced:

tube #	tube type
V4	5651
V5	5651

      (3) Additional Comments

      None

   b. Linear Power Supply — JUL 25 1983

      (1) Cleaned chassis — C.MB

      (2) Tested all vacuum tubes — C.MB

      Replaced:

tube #	tube type
V10	5751

      (3) Additional Comments

JUL 2 5 1983

c. Linear Pulse Amplifier
   (1) Cleaned chassis N/A ______
   (2) Tested all vacuum tubes ______
   Replaced: tube # tube type

   (3) Additional Comments
   None

JUL

d. Scaler Timer
   (1) Cleaned chassis
   (2) Tested all vacuum tubes
   Replaced: tube # tube type
   None

   (3) Additional Comments

JUL 2 5 1983

e. Safety Amplifier
   (1) Cleaned chassis
   (2) Tested all vacuum tubes
   Replaced: tube # tube type
   None

(3) Additional Comments

f. Area Radiation Monitor JUL 2 6 1983 CMB

(1) Cleaned chassis *

(2) Tested all vacuum tubes

Replaced: tube # tube type

(3) Additional Comments

*Solid State unit

g. Micro-Micro Ammeter JUL 2 ? 1983 CMB

(1) Cleaned chassis CMB

(2) Tested all vacuum tubes

Replaced: tube # tube type

(3) Additional Comments

JUL ? 1983

h. Fission Preamp CMB

(1) Cleaned chassis and inspected CMB

(2) Additional Comments

i. Public Address System JUL 26 1983 [initials] *

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

* Solid State unit

j. Log Count Rate Recorder JUL 26 1983 [initials]

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

k. Linear Recorder JUL 27 1983 [initials]

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

l. Period Recorder JUL 2 . 1983 Cc 7/83 / Cc 7/83

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

m. Log N Recorder JUL 27 1983 Cc 7/83 / Cc 7/83

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

n. PAT 60 JUL 27 1983 Cc 7/83 / Cc 7/83

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

o. Regulated Power Supply JUL 27 1983 [initials]

(1) Cleaned chassis ______ *

(2) Tested all vacuum tubes

Replaced: tube # tube type

tube #	tube type

(3) Additional Comments

* Solid State

p. Conductivity Brigge JUL 27 1983 [initials]

(1) Cleaned chassis ______ *

(2) Tested all vacuum tubes * Solid State

Replaced: tube # tube type

tube #	tube type

q. Safety Amp Preamp

(1) Cleaned chassis JUL 27 1983 [initials]

(2) Tested all vacuum tubes [initials]

Replaced: tube # tube type

tube #	tube type
None	

(3) Additional Comments

JUL 2 9 1983

2. Relay Test

   a. Console relays tested and replaced as per SOP 815 CMM3

   b. Additional Comments Replaced Log N Period Amp mop Shim Range, Reg. Rod interlock

3. Detector Resistance

OCT 3 1 1983

   a. Safety #1

	Value	
(1) Signal to ground	2.2×10^{11}	CMM3
(2) Positive to ground	0.074×10^{12}	CMM3
(3) Additional Comments		

OCT 3 1 1983

   b. Safety #2

	Value	Initial
(1) Signal to ground	0.165 ~~0.3~~ CMM3 $\times 10^{12}$	CMM3
(2) Positive to ground	0.3×10^{12}	CMM3
(3) Additional Comments		

OCT

   c. Log N

(1) Signal to ground	0.044×10^{11}	CMM3
(2) Positive to ground	5.6×10^{12}	CMM3
(3) Negative to ground	2.5×10^{12}	CMM3
(4) Additional Comments		

OCT

   d. Linear

(1) Signal to ground	0.68×10^{12}	CMM3
(2) Positive to ground	2.7×10^{12}	CMM3
(3) Negative to ground	0.75×10^{12}	CMM3
(4) Additional Comments		

4. Calibration Checks

Note: Any instrument found to be out of calibration should be realigned in accordance with its technical manual.

9-26-83

A. Temperature Recorder

1.

Reading #	Thermometer	Recorder
1	~~80~~ 70.4 °F	69°F
2	~~80~~ 70.4 °F	70°F
3	~~80~~ 70.4 °F	70°F
1	~~140~~ 127.6 °F	127°F
2	~~140~~ 129.8 °F	131°F
3	~~140~~ 132.8 °F	134°F

Note: All readings should be ± 1°F

2. 135°F Interlock	Trip Point	Initial
	135°F	CWM3

B. Log Count Rate Channel

1.

Pulse Generator*	Meter	Recorder	Initial
10	10	10	CWM3
100	100	100	CWM3
1000	1000	1000	CWM3
10,000	10000	10000	CWM3

Note: All readings should give .7 to 1.4 ratio of true-to observed readings.

2. Additional Comments

7-28-83

C. Linear

1.

Keithley	Meter	Recorder	Initial
$6.66X10^{-5}$	6.60	100	CWM3
$2.0X10^{-5}$	2.0	100	CWM3
$6.66X10^{-6}$	6.66	100	CWM3
$2.0X10^{-6}$	2.0	100	CWM3
$6.66X10^{-7}$	6.66	100	CWM3
$2.0X10^{-7}$	2.0	100	CWM3
$6.66X10^{-8}$	6.66	100	CWM3
$2.0X10^{-8}$	2.0	100	CWM3
$6.66X10^{-9}$	6.66	100	CWM3
$2.0X10^{-9}$	2.0	101	CWM3
$6.66X10^{-10}$	6.66	102	CWM3
$2.0X10^{-10}$	2.0	102	CWM3

Note: From 10^{-3} to 10^{-8} the overall accuracy should be better than 2% of full scal .

From $3X10^{-9}$ to $3X10^{-13}$ the overall accuracy should be better than 4%.

2. Additional Comments

AUG [illegible] 2 1983

D. Log N

1.

Meter	Recorder	Keithley	Initial
100	100.0	$5X10^{-5}$	CMB
10	10	$5X10^{-6}$	CMB
1	1	$5X10^{-7}$	CMB
0.1	0.1	$5X10^{-8}$	CMB
.01	0.01	$5X10^{-9}$	CMB
.001	0.0013	$5X10^{-10}$	CMB
.0001	0.0002	$5X10^{-11}$	CMB

Note: The ratio of true-to-observed readings should be between 0.7 and 1.4.

2. Additional Comments

5. Verification of Rod Drop Times

MAY [illegible] 1983

a.

Rod #	Rod Height (inch)	Separation Time (< 50 msec)	Rod Drop Time (< 600 msec at 24
1	6	21.6 msec	290 msec
1	12		360 msec
1	18		435 msec
1	24		490 msec
2	6	27.5 msec	275 msec
2	12		360 msec
2	18		430 msec
2	24		490 msec
3	6	25.7 msec	310 msec
3	12		380 msec
3	18		440 msec
3	24		510 msec

b. Date performed May 31 1983 Preformed by CMB

Director or Supervisor [signature]

6. Void Coefficient Determination

a. Value of void coefficient ______________ % $\Delta K/K/cm^3$

b. Calculation performed by ______________

c. Date performed ______________

d. Director or Supervisor ______________

7. Temperature Coefficient Determination

a. Value of temperature coefficient ______________ % $\Delta K/K/°F$

b. Calculations performed by ______________

c. Date performed ______________

d. Director or Supervisor ______________

8. Rod Speeds

Time (Sec)	I.	II.	III.	Reg.
0-24"	4 Min.	3 Min 59 sec	3 Min 58 sec	1 Min 1.5 sec.

(3) Additional Comment

Date JUL 2 8 1985 Performed By [signature]

9. Rod Indicator Calibration

JUL 2 8 1985

Actual Height	I.	II.	III.	Reg.
	Indicator Reading			
1"	1	1	1	1
6"	6	6	6	6
12"	12	12	12	12
18"	18	18	18	18
24"	24	24	24	24

10. Results of Annual Control Rod Inspection

A. Control Rod Number 1

Top of rod 6mr on contact
Middle of rod 40 mr on contact
Bottom of rod 5r/hr on contact
Rod looks fine.
Top of rod, magnet face cleaned.

Info Taken from Perm. Log Book # II page 28

11.b Control Rod Number 2

Top of rod 6 mr on contact
middle of rod 40 mr on contact
Bottom of rod 6 r/hr on contact
No major pitting, Tightened set screws
Info Taken from Perm. Log Book # VI page 28

11.c Control Rod Number 3

Top of rod 5 mr on contact
middle of rod 40 mr on contact
Bottom of rod 7 r/hr on contact
There is a 0.075" Bow at center of rod.
Rod is clean no major pitting
Info. Taken from perm. Log Book # VI page 28

d. Date Performed 7-19-83

e. Director or Supervisor [signature]

Date 18 Nov 19 83

I have reviewed the results of this Semi-Annual Check on this date and discussed any problems and/or errors with the operating staff.

Director ____________________ or Reactor Manager [signature]

APPENDIX C

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
S.O.P.:	REVISED: 2-2-84	PAGE 1 OF 3
TITLE: Index		

Rev.

WRITTEN BY: DRC *DRC*	APPROVED BY: *D. E. Kaston*

TITLE : Index

WRITTEN BY: DRC [signature] APPROVED BY: [signature]

TITLE : Index

WRITTEN BY: DRC	APPROVED BY: A. E. Bolon

for insertion and removal. This log entry shall include date and time.

16. A temporary change to the SOP's may be made with the consent of two licensed Operators, one being a licensed Senior Operator. This change shall be submitted in writing within ten working days to the Reactor Director for Approval or Revision. Rev.

17. If at any time during reactor startup or operation the Reactor Operator notices any abnormal behavior of the instrumentation (meters and recorders), he/she should immediately bring it to the attention of the Senior Operator on Duty. If there is any doubt as to whether the equipment is functioning properly, the reactor shall be shut down. Then the cause should be determined and corrective action taken. Rev.

WRITTEN BY: Dan Carter	APPROVED BY: Albert Bolon

TITLE: Pre-Startup Checklist Procedure

A. Purpose:

The purpose of the check list is to give definite assurance that all systems are operating correctly. A complete checkout of the reactor will be required, utilizing the current startup checkout form, any time the reactor is to be started up from a complete shutdown, that is if a shutdown check list has been completed, unless otherwise specified by the Senior Operator on Duty.

B. Precautions, Prerequisites, or Limitations:

1. It shall be the responsibility of the licensed operator checking the reactor out to make sure that all steps in the checkout list have been properly completed. In the event a student checks out the reactor as part of his or her training, the licensed operator must still accept the responsibility. The operator may assign various steps to be completed by unlicensed personnel, in which case, the responsibility still lies with the operator performing or supervising the checkout.

2. Immediately before the reactor is started up a startup check list must be completed.

3. After each step on the check list is completed the operator will record the readings made, or in cases where no readings are required, will simply check the appropriate blank on the form.

4. Any malfunctioning or abnormality of the reactor or components shall be immediately reported to the Senior Operator on Duty, and corrected before continuing with the checkout form.

5. After the check list is completed the Senior Operator on Duty must give final approval of the check list by initialling the completed form.

WRITTEN BY: Karen Lane	APPROVED BY: Albert Bolon

C. Procedure

Refer to the startup check list.

1. Use the rubber date stamp.

2. Record the time that is shown on the reactor console clock translated into military time.

3. Your initials.

4. Enter core loading number and mode.

5. Check or turn on these units. Number 6 is the bridge intercom.

6. Announce. "The building alarm will sound. This is a test. Do not evacuate the building."

7. Check the #1 Radiation Area Monitor (RAM) at its respective setpoints, i.e. ~10 mr/hr "High Radiation Alarm" and ~ 20 mr/hr "Building Evacuation Alarm." Depress the button on #1 RAM Amplifier and hold until the board annunciator and building alarm sound. Push scram reset, acknowledge, and reset buttons in that order. Repeat for #2, and #3 RAM, except there will be no building evacuation alarm. Push acknowledge, and board reset. Announce, "Test Complete."

8. See that all monitors read approximately 3 to 6 mrem/hr.

9. Ask the Senior Operator if the nitrogen diffuser pumps need to be turned on.

10. See that the beam port and thermal column lights are off. Check status of experiments.

This completes the preliminaries.

Now a "static test" of the instrumentation will begin.

11. Depress the zero check button and adjust meter to

read zero. If the linear micro-micro ammeter reading is not between 0.2 to 0.8 on the 3×10^{-11} range, ask the Senior Operator on Duty to adjust the compensating voltage. Record the meter reading. Record the scale.

12. These are the compensated ion chamber voltages. Record #1 (Linear) power voltage. Hold meter range switch down for negative (compensating) voltage and record. Then do the same for #2 (Log N). (Normal reading should be approximately 510, 5, 580, 6.)

13. Open the recorders. Turn them on. Leave the glass doors open. Date each recorder chart. Close doors and push the reset button. The "Recorder Off" light should be off.

14. Turn on pool lights. Check the water level in the pool. Position the neutron source near the log N/period compensated ion chamber and check that both the period and log N recorders have responded properly. Insert the source in holder. Look at the core and pool for foreign objects that may have fallen in. Check the in-core experiments. Be careful of things in your shirt pockets.as they may fall in the pool.

15. Turn selector switch on Log Count Rate meter to 10^2, 10^3, 10^4. See if meter and recorder follow. Return to the "OPERATE" position.

16. Depress fission chamber insert switch and hold down until the green insert limit light comes on.

17. Turn on scaler, make sure it is counting.

18. Depress fission chamber withdraw switch. Hold down until the counts start to decrease.

19. Reinsert fission chamber to insert limit. Make sure recorder is reading greater than 2 counts/sec.

20. Turn switch on Log N meter to "LOW". (The Log N

recorder should read about 0.01.) Quickly turn switch to "HIGH". (The recorder should read about 8 kW.) Push acknowledge and board reset.

21. Turn period "CALIBRATE" switch. Hold until period recorder reads 6 seconds. Check the annunciator panel for Log N and Period Nonoperative, 30 sec and 15 sec periods lights. Push acknowledge and board reset.

This completes the "static test" of the instruments.

The next section of the checklist tests the console under actual operating conditions.

22. The magnet power key is normally kept in the locked safe. When the key is given to you insert it into the console and turn on the magnet power. Push scram and board reset buttons to clear the annunciator panel and energize the magnets.

23. Record magnet readings. Set selector switch on the magnet power supply to #1, #2, #3. (Typical readings should be about 85, 65, 45.)

24. Withdraw shim/safety rods 3 inches using the gang joy stick. Depress test button on safety amp and hold until the 4 red lights come on. Push acknowledge and reset buttons and reset the safety amp. Check that the blue magnet contact lights are out indicating the rods have dropped. (Note. If a magnet contact light is not out refer to SOP 305.) Run the rod drives back down.

25. Again withdraw shim/safety rods 3 inches. Turn period test switch on Log N meter clockwise to "CALIBRATE". Hold and wait for the period recorder to indicate a 6 second period. Push acknowledge button. Check for Log N Inoperative Scram, Manual Scram, 15 second rundown, and 30 second period lights on annunciator panel. Push scram reset, rundown reset, and board reset buttons. Check that all magnet contact lights are out and then run rod drives back down.

26. Raise shim/safety rods 3 inches and push the manual scram button. Check to see if rods have dropped by observing the video display and noting whether the blue magnet contact lights are off. Push acknowledge, scram reset and board reset buttons, and run down the rod drives.

27. Push annunciator test button. Check for burned out bulbs. Acknowledge and reset.

28. All blue magnet contact lights should be on and the regulating rod on insert limit.

29. Prepare hourly and permanent logs.

30. Raise shim/safety rods to 6 inches record the time in both logs.

31. Inspect the core. Make certain core cooling is clear and experiments are firmly secured.

32. Announce, "The reactor will be started and taken to a power level of ___ watts (or ___kilowatts)."

33. Record the intended power level, including W or kW.

34. Review the pre-startup checklist to make certain that all the steps have been completed.

35. The Senior Operator must initial the check list. This completes the check list.

TITLE : Pre-Startup Checklist Procedure

UMRR PRE-STARTUP CHECK LIST
(SOP 102)

1. Date							
2. Time (Console Clock, Military Time)							
3. Operator's Initials							
4. Core Loading and Mode (W or T)							
5. Intercom, P.A., T.V. Camera & Monitor On							
6. Announce RAM Check							
7. Check RAM System							
8. Radiation Level Normal							
9. Nitrogen Diffuser On, Light Lit (Required when P > 20kW)	No. 1						
	No. 2						
10. Beam Room	Beam Tube and Thermal Column						
	Experiments Set for Run						
11. Linear Level	Zero the Meter						
	Meter Reading (Most Sensitive Scale)						
	Scale						
12. C.I.C. Readings	No. 1						
	No. 1 - (Hold meter range switch down)						
	No. 2						
	No. 2 - (Hold meter range switch down)						
13. Recorders: On, Ink, Paper, Date							
14. Pool	Lights On, Level Check,						
	Log N Recorder Spike						
	Period Recorder Spike						
	Insert Source						
	Inspect Core (Expts., etc.)						
15. Test Log Count Rate (Use Recorder)							
16. Insert Fission Chamber to Insert Limit							

Rev.2, 2/2/84

WRITTEN BY: Karen Lane *Karen Lane* | APPROVED BY: *Albert Bolon* Albert Bolon

TITLE : Pre-Startup Checklist Procedure

UMRR PRE-STARTUP CHECK LIST
Page 2

17. Scaler on Count and Counting						
18. Check Fission Chamber Response						
19. Fission Chamber on Insert Limit and Count Rate Greater than 2 CPS						
20. Test Log N Recorder Response						
21. Test Period Recorder Response						
22. Magnet Power On, Scram Reset, Board Reset						
23. Magnet Currents (Read Values)	No. 1					
	No. 2					
	No. 3					
24. Check 150% Power Scram	Raise Rods 3 in. Push "Test" Button On Safety Amp Panel					
25. Check Log N/ Period Non-Operative Scram and 15 sec Period Rundown	Raise Rods 3 in. Select Switch to Calibrate					
26. Test Manual Scram	Raise Rods 3 in. Push Manual Scram					
27. Test Annunciator, All Lights On						
28. All Magnet Contacts Made, Reg. Rod on Insert Limit						
29. Prepare Hourly and Permanent Logs						
30. Raise Rods to 6 in., Record Time						
31. Inspect Core						
32. Announce Intention to Start						
33. Intended Power Level						
34. Pre-Startup Check Completed						
35. Senior Operator's Initials						

Rev.2, 2/2/84

TITLE: Reactor Start Up Procedure

A. Purpose To insure a safe and consistent method for starting up the reactor from a clean or high residual condition. The reactor will be considered clean if shutdown for more than 52 hours. The reactor will also be considered clean if power levels within the past 52 hours have not exceeded 20kW for 1.0 hour or it's equivalence.

B. Precautions, Prerequisites, Limitations

1. SOP 102 shall have been completed and approved by the SRO on Duty prior to commencing reactor startup.
2. The SRO on Duty shall remain in the control room (audible and visual contact with console operator) during startup, power-change and shutdown of the reactor.
3. There will be at least two, but no more than nine people in the control room during reactor startup, power change or shutdown.
4. When the reactor is in a stable condition there shall be no more than nine people in the control room at any time. One of these individuals shall hold a valid Operators license or Senior license.
5. The console operator (licensed RO or student under supervision of SRO) shall control all reactivity changes to the reactor by direct manipulation of the controls or by directing the manipulation of experiments being conducted at the facility.
6. Only a licensed Senior Reactor Operator may terminate the action of automatic reactor controls. If a scram, rundown or rod withdrawal prohibit occurs with a licensed Operator or student at the control, the permission to terminate the automatic control or a restart of the reactor can only be authorized by a licensed Senior Reactor Operator.
7. Nitrogen diffuser operation is required for reactor power greater than 20 kilowatts. This requirement is at the

WRITTEN BY: KGL	APPROVED BY: Albert Bolon

discretion of the Senior Operator on Duty and may be suspended for special tests, experiments or equipment checks. The reactor bridge radiation levels shall not be allowed to equal or exceed 30 mr/hr.

8. Building exaust fan operation is required for reactor power level of 200 kilowatts or when the constant air monitor recorder reaches a value of 500 counts/minute. Exhaust fan operation should continue after the reactor is shutdown until a less than 500 counts/minute reading is obtained or until the reactor building is secured at the end of the day. See SOP 505 for securing the reactor building.

9. The safety channel meters should begin to give a definite positive indication when the reactor power is at about 5 kW. Rev.

10. If the desired reactor power is greater than 20 W, the reactor shall first be taken to 20 W, (or some similar low power as specified by the Senior Operator on Duty), put in automatic control, and the hourly logs taken. The Reactor Operator shall check that all instrumentation is functioning properly.

11. If the desired reactor power is greater than 20 kW, the reactor shall be taken to 20 kW, put in automatic control, and the hourly logs taken. The Reactor Operator shall check that all instrumentation is functioning properly, especially the safety (power) channels.

C. Procedures

1. Clean core, shim rods at 6 inches and neutron source installed.

   1. While observing the log count rate recorder for any unexpected increase, withdraw all shim rods to shim range. Do not exceed an rod position indicator value of 12.5 inches. The shim range indication lights (yellow-below rod position indicator for each shim rods) will come on

WRITTEN BY: Karen Lane *Karen Lane* | APPROVED BY: *Albert E. Bolon* Albert E. Bolon

between 12.0 and 12.5 inches.

2. While observing the log count rate recorder for any unexpected increase, withdraw the regulating rod to 15.0 inches. Note the increase in counts per second on the log count rate recorder.
3. While observing the log count rate recorder withdraw the shim rods an additional 1.0 inch. The console operator should not obtain a slope of less than 1.0 (angle of less than 45° from horizontal) during or after rod withdrawal.
4. Monitor the value on the linear recorder. If the reading reaches 80% of selected scale, change the range selector switch one position counter clockwise (up scale).
5. Continue steps 3 and 4 until a shim rod height of 18.0 inches is obtained. Pause for a short amount of time between each 1.0 inch withdrawal, (approximately 5 seconds).
6. While observing the log count rate recorder withdraw the shim rod an additional 0.25 inches. The console operator should not obtain a slope of less than 1.0 (angle of less than 45° from horizontal) during or after rod withdrawal.
7. Continue steps 4 and 7 until the reactor goes critical. Pause for a short amount of time between each 0.25 inch withdrawal. When the log count rate recorder shows a steady constant increase in value without shim rod withdrawal is an indication that the reactor is critical.
8. Observe the log n recorder and the period recorder for indication that they are within their operating range. The period recorder will indicate a period of less than infinity (∞) and there will be an increasing power level indication on the log N recorder (vertical line).

Rev.

Typically the period and log N meters and recorders will begin to provide positive indications when the log count rate recorder is at approximately $3x10^3$.

9. When the log count rate recorder reaches full scale (10^4) withdraw the fission chamber until an log count rate recorder reading of 10^2 is obtained. Prior to withdrawal of the fission chamber the operator shall have indication of reactor power on the linear and log n recorders.
10. Establish a reactor period as requested by the Senior Operator on Duty, (or approximately 50 seconds) and continue the reactor power increase to the desired power level on the linear range selector.
11.* When the linear recorder reaches approximately 98% a "green" Auto Permit light will come on. This will allow the regulating rod to be placed in Automatic Control (signal from linear recorder). When the auto permit light occurs, insert the shim rods in "bumps" until the period recorder indicates a reactor period of approximately 400 seconds.
12.* Allow reactor power to increase to 101% on the linear recorder and place the regulating rod in automatic control. This is done by placing the "Manual Auto" switch (below the auto permit light) in the auto position. When the "Auto" light comes on release the switch (return to neutral).

***Note: This step assumes an auto setpoint at 100% of linear recorder, for values other than 100% the shim rod insertion should occur at -2% of setpoint and "auto" selected at +1% of setpoint.**

WRITTEN BY: Karen Lane *Karen Lane* | APPROVED BY: *Albert Bolon* Albert Bolon

13. Insure that the regulating rod momentarily inserts (white light) and is satisfactorily controlling reactor power at the intended setpoint (red pointer on linear recorder).
14. Reset the Manual Operations Annunciator.
15. Record the time from the console clock in the Hourly Log (time at power).
16. Inform personnel of the reactor power level on the building public address system. "The reactor is at a power level of ________ watts or kilowatts".
17. Position the fission chamber to achieve a log count rate recorder indication of 10^2 (mid scale).
18. Complete Hourly Logs in accordance with SOP 104.

WRITTEN BY: Karen Lane *Karen Lane*	APPROVED BY: Albert Bolon *Albert Bolon*

TITLE: Permanent Log, Hourly Log and Operational Data

A. Purpose

To provide for records of facility operation and major maintenance. Any work affecting the reactor, its operation and specific use during operation must be clearly and legibly described in the Permanent Log book. Hourly logs will detail specific instrument readings while the reactor is in operation.

B. Precautions, Prerequisites, or Limitations:

1. All log entries are to be made with times recorded from the console clock.

2. a) The reactor operator shall make entries in the log book when the reactor is at a stable power level with the Reg Rod in "Auto", or b) the reactor is at a stable power level, the Reg rod is in "Manual" and an operator assistant is available to record log entries (see SOP 102 or 103 for other conditions prior to log entries).

3. The Senior Operator on Duty is responsible for all operational logs. Request his assistance if in doubt about log entries.

4. All scrams and rundowns shall be noted with an explanation of the cause and corrective action in the Permanent Log.

5. The Senior Operator on Duty will review all log entries following completion of daily operations.

6. The Senior Operator on Duty will report any abnormal conditions entered in the operational logs to the Reactor Manager.

WRITTEN BY: Carl Barton 2/1/83	APPROVED BY: A. E. Bolon Albert E. Bolon

C. Procedure

1. Hourly Log Entries

a. The hourly log sheet will be dated and each operator (student, trainee, etc.) will place their signature in appropriate spaces provided.

b. A new hourly log sheet will be started at the beginning of each operational day, or when all available columns have been filled during the current day of operation, (i.e. a new hourly log sheet is not required for each startup checklist SOP 102).

c. The following procedure steps correspond to the numbered steps on form SOP 104.

1. Time from console clock, based upon 24 hour time.
2. Operator at the controls, initials.
3. Reactor power, as required by SO on duty.
4. Linear level recorder reading in percent.
5. Linear Level Amplifier Selector Switch scale.
6. Reg Rod in "Auto", yes or no.
7. Log N Recorder reading in kilowatts.
8. Shim Rod #1 Rod Position Indicator Reading to three places (ie.21.2)
9. Same as Step 8 for Shim Rod #2.
10. Same as Step 8 for Shim Rod #3.

11. Same as Step 8 for the Regulating Rod.

12. Check Radiation Area Monitors (Reactor Bridge, Demineralizer and Beam Room) for approximately the same values observed during completion of startup checklist (SOP 102).

13. Record Reactor Bridge RAM reading in mr/hr.

14. Check Magnet Currents for approximately the same values observed (and recorded) during the startup checklist (SOP 102).

15. Reactor Power Level indicated on the #1 Power Range Meter in percent. This meter corresponds to 200 kilowatts at 100%.

16. Same as Step 15 and #2 Power Range Meter.

17. Record the time at which a stable power level was obtained in the Permanent Log. Other entries to the Permanent Log such as samples being irradiated, etc. should also be made at this time. (See section 2 of SOP 104).

18. Record the Reactor Inlet Temperature as displayed on the Pool Water Temperature Recorder.

19. Project or Class Number for which the reactor is being utilized.

20. Core Loading Number as given to you by the Senior Reactor Operator on Duty.

2. Permanent Log Entries

a. All entries in the Permanent Log shall be preceded by the date (Use the date stamp).

b. During completion of the Startup Checklist (SOP 102) use the Check Out stamp and complete values as they become available. To the right of the purpose the

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TITLE: Permanent Log, Hourly Log and Operational Data		

nature of the experiment should also be shown. See the example below:

1000	Time Check Out Started
1030	Time Rods at 6 Inches
NE 304	Purpose [illegible]
1100	Time Reactor at 0.05 kw

c. Reactor power changes are made in accordance with SOP 103 and entries are made prior to the start of a power change and at the new stable power level. The example below indicates Permanent Log entries for a power change including shutdown of the reactor:

1028 Reactor started to 600W.
1030 Reactor at 600 W.
1035 Reactor shutdown.

d. The Sample-Experiment stamp is used to indicate the irradiation of a sample as a Permanent Log entry. This stamp will be used to indicate the production of by-product material. The example below indicates the use of this stamp.

WRITTEN BY: Carl Barton	APPROVED BY: Albert E. Bolon

EXPERIMENT

OPERATOR Ronald Wood

CORE OR FACILITY POSITION	EXPERIMENTER AND EXPERIMENT	START TIME	STOP TIME	TOTAL TIME
Bare Rabbit	Nancy Wood Au-foil irradiation (2)	1130	1200	30 min

Note: The number in parentheses () indicates the number of samples.

3. Recorder Chart Paper Entries

a. Date all 5 primary recorders in accordance with SOP 102 (startup checklist) and SOP 105 (shutdown checklist).

b. Recorder chart paper is to be replaced immediately after the current roll chart supply is used. During replacement use the new chart box for the old chart storage. Date both the old chart and all sides of the chart box. Place the chart on storage shelves adjacent to the control room.

c. All chart paper is retained for a period of TWO YEARS except for the Log N Chart which is retained for the duration of the facility.

4. Ventilation Fan Log Entries

a. After receiving approval from SRO to start or stop a

building exhaust ventilation fan, complete the requested information on the Fan Operation Log (i.e. time, fan #, power level etc.)

b. Fan Operation Logs are retained in the Facility Health Physics files.

UMRR HOURLY OPERATING LOG

(SOP 104)

(Start a new form each day.)

Operator's Signature: (1)________________ (3)________________

(2)________________ (4)________________

Date________________

1. Time at Power											
2. Operator's Initials											
3. Nominal Power (W or Kw)											
4. Linear Level Recorder (%)											
5. Linear Level Scale (Amps)											
6. Auto Set (yes or no)											
7. Log N (Kw)											
8. Shim Rod No. 1 (inches)											
9. Shim Rod No. 2 (inches)											
10. Shim Rod No. 3 (inches)											
11. Regulating Rod (inches)											
12. Radiation Levels Normal											
13. Record Bridge Monitor (mr/hr)											
14. Magnet Currents Normal											
15. Power Chamber No. 1 (%)											
16. Power Chamber No. 2 (%)											
17. Permanent Log Entries											
18. Core Inlet Water Temp (°F)											
19. Project or Class Number											
20. Core Loading											

Senior Operator's Signature at End of Day____________________

NOTE: Readings shall be taken at hourly intervals or less during any reactor run. Readings shall also be taken after reaching power, or after having changed power level. All scrams and rundowns shall be noted with explanation of cause of scram or rundown in the permanent log book.

Rev. 2, 2/1/84

WRITTEN BY: Carl Barton (signed: Carl Barton) | APPROVED BY: Albert Bolon (signed: Albert Bolon)

TITLE: Estimation of Activity and Reactivity Worth of a Sample

A. Purpose

The purpose of this procedure is to provide guidance for calculating the radioactivity and reactivity before irradiating samples in or near the core.

B. Precautions, Prerequisites, or Limitations

Samples may come out of the reactor with very high radiation levels due to their composition and/or encapsulation. They may also have an adverse reactivity effect on the reactor. This could lead to a violation of reactivity limits and/or the initiation of a reactor shutdown. For this reason calculations must be performed to evaluate the reactivity effects as well as the activity levels of every sample or group of samples prior to irradiation (SOP 702).

C. Procedure

1. Calculation of Activity

$$\text{Act (dis/sec)} = \frac{a \times m \times NA}{AW} \times \sigma_a \times \Phi\{1-\exp(-\frac{0.693t}{T_{1/2}})\} \quad \text{(eq.1)}$$

where m = Mass of the element to be irradiated (grams)
a = Isotopic abundance of the element
NA = Avogadro's Number (6.02×10^{23} atoms/mole)
AW = Isotopic atomic weight (grams/mole)
σ_a = Isotopic activation cross-section (cm^2)
Φ = Neutron flux (n/cm^2-sec)
$T_{1/2}$ = Half life of the produced radioisotope (min)
t = Irradiation time (min)

WRITTEN BY: Milan Straka, Daniel R. Carter | APPROVED BY: Albert Bolon

Sample Calculation:

A 0.0985 gm sample of Al^{27} is to be irradiated in a flux of 5×10^{10} n/cm^2-sec. What is the activity after 5 min. of irradiation? ($\sigma_a = 0.241\text{b} = 0.241 \times 10^{-24}$ cm^2, $T_{1/2}$ = 2.24 min, 3.7×10^7 dis/sec = 1 mCi)

$$Act = \frac{1 \times 0.0985 \times 6.02 \times 10^{23}}{27}(0.241 \times 10^{-24})(5 \times 10^{10})\left[1 - e^{-\frac{(0.693)(5)}{2.24}}\right] = 2.08 \times 10^7 \text{ dis/sec} = 0.56 \text{ mCi}$$

2. Calculation of Reactivity Worth of a Sample

The reactivity worth of a sample when placed in the neutron flux Φ_s can be calculated by comparing it to the reactivity worth ρ_a of a known absorber placed in the neutron flux Φ_a using the following formula

$$\rho_s = \rho_a \times \frac{\sigma_s}{\sigma_a} \times \frac{m_s}{m_a} \times \frac{AW_a}{AW_s} \times \left(\frac{\Phi_s}{\Phi_a}\right)^2 \qquad \text{(eq.2)}$$

where

σ = Microscopic absorption cross-section (barns)
m = Mass (grams)
AW = Atomic weight (grams/mole)
Φ = Neutron thermal flux (n/cm^2-sec.)

Subscripts "s" and "a" stand for the sample and absorber properties.

Using data from a reactivity experiment with a piece of indium absorber placed in the position D-5 at the reactor power of 20W the formula (2) can be simplified to

$$\rho_s \left(\frac{\Delta k}{k}\right) = 10^{-21} \frac{\sigma_s m_s}{AW_s} \times \Phi_s^2 \qquad \text{(eq.3)}$$

(Note: The value of the neutron flux Φ_s must correspond to the reactor power of 20 W.)

WRITTEN BY: Milan Straka, Daniel R. Carter	APPROVED BY: Albert Bolon

Sample Calculation:

A 2.0 gm sample of Al-27 ($\sigma = 0.241$ barns) is to be irradiated in a flux of 2.6×10^{10} n/cm^2 sec. at 2 kW. What is the expected reactivity worth?

$$\rho_s = 10^{-21} \times \frac{0.241 \times 2.0}{27} \times \left[2.6 \times 10^{10} \times \frac{20}{2000}\right]^2$$

$$= 1.2 \times 10^{-6} \ \Delta k/k$$

3. Calculation of Reactivity Worth of a Void

When a void is placed in or near the reactor core a change in reactivity can be expected. This is due to the void coefficient of reactivity. A void itself will add negative reactivity to the reactor, but the greatest concern is the removal or collapse of a void which wil add positive reactivity.

The void coefficient as of 12/7/83 is $-6.56 \times 10^{-7} \Delta k/k/cm^3$ at the core periphery.

Sample Calculation:

A sample will be placed next to the core in an empty 250 ml bottle. What is the change in reactivity due to the void?

$$\rho = 250 \ cm^3 \ (-6.56 \times 10^{-7} \ \Delta k/k/cm^3) = -1.64 \times 10^{-4} \ \Delta k/k.$$

WRITTEN BY: Milan Straka, Daniel R. Carter	APPROVED BY: Albert Bolon

Physicist to collect the following data immediately and to insure that the required action is carried out.

1. From information available such as direction of travel of the cloud, weather conditions, and an estimate of the amount of fuel atomized, the Health Physicist shall decide if it will be necessary to advise any of the surrounding communities of an impending radiation hazard. He also will insure that all UMR personnel, working in areas other than the reactor area, remain or proceed indoors where all windows and doors will be tightly closed and all supply and exhaust ventilation fans will be shut down.

2. If, from the data collected, a hazard to any community cannot be ruled out, he will advise the Director of Administrative Planning giving him all necessary information. The Director will, in turn, notify the communities which might be affected.

H. End of Emergency

The Reactor Director, or the Reactor Manager, and the Radiation Safety Officer shall decide when the emergency no longer exists. Any special precautions regarding the existence of residual contamination shall be issued by Health Physics before personnel are allowed back into the area. SOP 601 shall be followed for decontamination.

I. Notification of Key Personnel

Notification of key personnel shall be in the order listed for any emergency that may occur at the reactor facility.

1. Reactor Manager, Milan Straka

Campus Telephone	341-4237
Home Telephone	364-5276
Home Address	705 W 12th, Rolla, Mo. 65401

2. Reactor Director, Albert E. Bolon

Campus Telephone	341-4236
Home Telephone	364-1961
Home Address	Rt. 4, Box 33, Rolla, Mo. 65401

3. Health Physicist, Ray Bono

Campus Telephone	341-4240
Home Telephone	364-5728
Home Address	Rt. 4, Box 190 Rolla, Mo. 65401

4. Radiation Safety Officer, Nicholas Tsoulfanidis

Campus Telephone	341-4745
Home Telephone	341-3595
Home Address	Rt. 6, Box 523 Rolla, Mo. 65401

5. Reactor Maintenance Engineer, Dan Carter

Campus Telephone	341-4236
Home Telephone	364-8628
Home Address	308 E. 12th, Rolla, Mo. 65401

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 701	REVISED: 12-15-83	PAGE 1 OF 6

TITLE: Request for Reactor Projects

A. Purpose

In accordance with Technical Specification 6.2.2 each project shall be reviewed and approved prior to insertion in the reactor.

B. Precautions, Prerequisites, or Limitations

The use of the reactor shall be restricted to persons listed on an approved Project Request Form. The exception to this is the pilot run of a project which may be run under the project NRF (Nuclear Reactor Facility). This shall not be done more than twice on any project.

Section 6.0 (Experiments) of the Technical Specifications limits the type ofmaterials that shall be irradiated at this facility. In addition to the limits of Section 6.0 plastics shall not be exposed to a neutron fluence in excess of 1×10^{16} neutrons/cm^2.

All projects shall be reviewed for compliance with the Technical Specificatons by the Reactor Staff.

C. Procedure

The individual who will be in charge of the project will be responsible for properly completing a Project Request Form (Form SOP 701). The form is submitted to the Reactor Manager. After approval by the Reactor Staff, the request is forwarded to the Reactor Director, Health Physics Office, and the Radiation Safety Committee. Only after approval by the Committee is a project number assigned and an experimenter allowed to run experiments. Copies of the approved Project Request Form are distributed: one copy to the Radiation Safety Committee, one copy to the Reactor Facility, and one copy to the originator.

For each individual run, the experimenter shall submit the Irradiation Request Form (SOP 702).

WRITTEN BY: Milan Straka	APPROVED BY: Albert Bolon

Particular instructions are given below for completing the Project Request Form:

Item

5. The best estimate in hours should be given to facilitate reactor scheduling.

6. Equipment to be brought to the reactor or extra facility equipment requested should be listed.

9. If radioactive materials are to be removed from the reactor building, the person removing the material must have an NRC license to possess and transport this material. For University of Missouri personnel this is covered under the University Board License and individual staff members can request a UMR License. (For more information contact UMR-Health Physics Office.)

10. If the project is not sponsored, write "none" after sponsoring agency. If the project is sponsored please list the account number for billing purposes.

12. A brief description is required. This should be suitable for listing in the Annual Report or other publications. The Reactor Facility is participating in the National Academy of Science Research Reactor Utilization Project to study the utilization of University reactors. One item they periodically request is a one page description of each active project.

13. An analysis of possible hazards associated with the performance of experiments must be included. This includes the evaluation of the health physics and reactor safety problems; such as sample encapsulation, its expected reactivity worth, and activity of sample at time when removed from the reactor. The list of

above-mentioned problems is not exhaustive, the details required in the hazards and safety analysis depend markedly on the experiment performed. (If assistance is needed with the hazards and safety analysis of the experiment contact the Reactor Staff.)

TITLE: Request for Reactor Projects

1. Date Submitted ______________ Date Approved by Reactor Staff __________

   Date Approved by Radiation Safety Committee ______________________

2. Type of Project: Special Problem, __________ Faculty Research __________

   M.S. Research ____________ PhD. Research ____________

   Laboratory Experiment, ________________________.

3. Faculty Member in Charge ________________________

4. Other persons authorized to use Project Number:

   1. ______________ 2. ______________ 3. ______________

5. Estimate Requested Time (in hours) for Each Facility:

   Reactor __________, Thermal Column __________, Beam Tube __________,

   NaI Counters ________ Pneumatic Tube, ______ Multi-channel analyzer ________

6. Extra Equipment to be used in the Facility (please list):

   ____

   ____

7. Estimated Starting Date ______________ Completion Date ______________

8. Maximum Length of Single Reactor Run ______ hrs.

9. List your NRC License No. ______________ or U.M.License No. __________

   (Please attach copy of license).

10. Sponsoring Agency ________________________________

    Title of Contract or Grant ________________________________

    Will the Nuclear Facility time be paid for by this agency? ______ yes

    ______ no

    If no, explain: ________________________________

11. Remarks ________________________________

    (Signature of Faculty Member in Charge) ________________________

    Date ________________

Date ____________ Project Title ____________

Faculty Member in Charge ____________

12. Description of Project:

13. Hazard and Safety Analysis:

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 702	REVISED: 12-15-83	PAGE 1 OF 2

TITLE: Request for Irradiation

A. Purpose

The purpose of this procedure is to assure that prior to each irradiation the details are established and that materials which are not supposed to be irradiated are not.

B. Precautions, Prerequisites, or Limitations

Researchers should read the Technical Specifications in order to know which materials are not supposed to be irradiated (T.S. 6.2.7 through 6.2.9).

An estimate of the activity of the sample and its reactivity worth must be done prior to irradiating samples.

There are Technical Specification limits on the reactivity worth of movable and immovable samples or experiments (T.S. 6.2.3 and 6.2.4).

C. Procedure

The UMR Reactor Irradiation Request Form 702 Rev.1 shall be completed and submitted with each sample or group of samples to be irradiated. If a group of samples are to be irradiated at the same time, please note the number in item 11.f. The items in the form require no special explanation, except items 12. and 13. A procedure to calculate expected activity of a sample and its reactivity worth is given in SOP 306.

It is suggested that the form be submitted on Friday prior to the week in which the irradiation is requested.

The lower part of the form shall be completed by the Reactor staff. Before irradiation, the form must be signed by two of the four persons designated under item 18.

WRITTEN BY: Milan Straka	APPROVED BY: Albert Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
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TITLE: Irradiation Request Form		

____

1. Name______________________________
2. Address______________________________
3. Telephone Number______________________________
4. Project or Class Number______________________________
5. Purpose of Experiment______________________________
6. NRC or UMR License Number (if applicable)______________________________
7. Equipment or Facility to be Used______________________________
8. Date to be Performed______________________________
9. Power Level Desired______________________________
10. Irradiation Time______________________________
11. Description:
    a. Material______________________________
    b. Physical Form______________________________
    c. Chemical Purity______________________________
    d. Weight______________________________
    e. Type of Encapsulation______________________________
    f. Number of Samples ______________________________
12. Expected Activity ______________________________
13. Expected Reactivity Worth______________________________
14. Remarks ______________________________
    ____
15. Signature ______________ Date______________

FOR REACTOR STAFF USE ONLY

16. Date Received______________
17. Analysis of Possible Hazards______________________________
18. Approved:
    Reactor Director______________________________
    Reactor Manager______________________________
    Reactor Engineer______________________________
    Health Physicists/Radiation Safety Officer______________________________

WRITTEN BY: D.R. Carter *D.R. Carter*	APPROVED BY: A.E. Bolon *A.E. Bolon*

3. Depress trip test switch, and rotate test pot for a five second period reading on the period meter.

4. Adjust R5 ccw until the meter (VOM) trips to zero VDC.

5. Release the trip test switch.

6. Adjust R12 clockwise until the meter (VOM) trips to ≈13.5 vdc.

7. Adjust R5 three turns clockwise.

8. Repeat steps 4,5,& 6.

9. Remove test meter (VOM).

10. Reconnect CIC signal cable. (This step is very important. Failure to reconnect the signal cable can cause a violation of the Technical Specifications, if the reactor is operated.) Rev.

11. Have another, knowledgeable person independently verify that the reconnection has been made. Rev.

WRITTEN BY: Carl Barton	APPROVED BY: Albert Bolon

UNIVERSITY OF MISSOURI-ROLLA

Nuclear Reactor Facility

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

April 20, 1984

United States
Nuclear Regulatory Commission
Washington, D.C. 20545

Re: License R-79, University of Missouri - Rolla Reactor
Docket No. 50123

Dear Sirs:

The following Progress Report for the University of Missouri - Rolla Reactor (R-79) for the period April 1, 1983 to March 31, 1984, is sent for your review and inspection.

Sincerely,

Albert E. Bolon

Albert E. Bolon, SO
Reactor Director

M Straka

Milan Straka
Reactor Manager, RO

AEB/kl
Enclosures (10 copies)

Signed before me this 26th day of April, 1984.

Loretta Paulson

Notary Public

LORETTA PAULSON, Notary Public
STATE OF MISSOURI
Phelps County
My Commission Expires Aug. 26, 1986.

A020
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