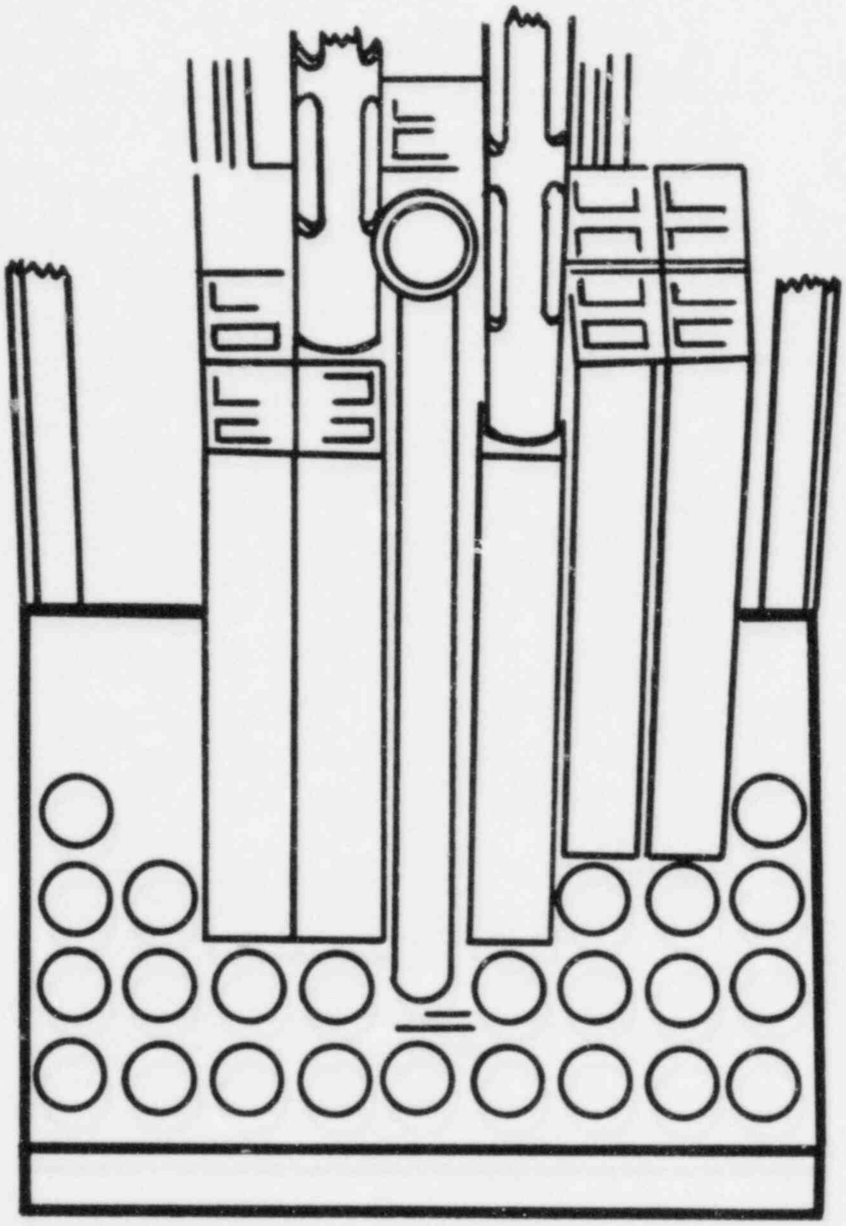
Progress Report

1982-1983

University of Missouri-Rolla

Nuclear Reactor Facility



A020
s/
1/20

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

APRIL 1, 1982 to MARCH 31, 1983

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 1328 hours. The major part of this time, 98.4%, was used for class instruction and training purposes. About 0.6% of the reactor time was used for research and about 1% was needed for the maintenance runs. Relating to the time classes were in session at the University of Missouri-Rolla (40 wks) the reactor was operating during 81.7% of this time for educational use.

It should be noted that the facility had only two licensed senior operators until December 1982, and only one during the remaining period of time. (Normally, there are three licensed senior operators available.)

Approximately 2.1 MW-hrs of energy was produced using 0.108g of U-235. A total of 289 samples were irradiated during this reporting period with most of the samples being used and analyzed at the reactor facility.

The reactor was visited by 2170 visitors during the past year. This is an increase of 14% when compared to the last reporting period. At the same time there were 42 UMR students enrolled for courses at the Reactor Facility. The facility was thus committed to over 71 student-hours of classes during the fall and spring semesters. There were only limited classes at the reactor during the summer of 1982 to allow for extended maintenance.

A pilot educational program was performed for graduate students of the Nuclear Engineering Department of the University of Arkansas, Fayetteville consisting of advanced reactor experiments and some preliminary neutron dosimetry measurements. Similar programs are being prepared for some

universities and colleges from the Midwest region. Funding has been requested from the University Reactor Sharing Program sponsored by the Department of Energy.

Table of Contents

List of Tables

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).

This 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 have made use of this 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 1)	Reactor Manager
Daniel Carter	Reactor Maintenance Engineer
Carl Barton	Electronic Technician
Karen Lane	Secretary
Juls William	Assistant Lab Mechanic
Mike Middleton 2)	Senior Operator
Phil Myers	Student Assistant Level II

B. Licensed Operators

Name	License
Albert E. Bolon	Senior Operator
Daniel Carter	Reactor Operator
Carl Barton	Reactor Operator
Karen Lane	Reactor Operator
Michael Middleton 2)	Senior Operator

1) Started on March 1, 1983.

2) Resigned effective on December 21, 1982.

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, which serves as the Reactor Advisory 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 1982. The second audit, in December 1982, was performed by Dr. J.C. McKibben and Mr. Walter Meyer, both from the Reactor Facility of the University of Missouri-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.

Slow Neutron Chopper: A slow neutron chopper is available for student use at the reactor facility. This chopper, was constructed as a Masters research project, and can be mounted on the face of the thermal column door.

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) The tube-type scaler/timer unit in the control room was replaced by a solid-state one.
2) The power supply to the neutron fission chamber was changed to solid-state.
3) Programming is being done on the Apple II computer to facilitate a weekly update of the facility's operation and fuel usage.
4) A detailed Emergency Plan has been prepared and submitted for approval by the NRC.

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 3 (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*

1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
P	CA													

RACK STORAGE FACILITY

				F-13	F-20	HF-1	F-22	F-2	F-5	F-3			F-18	F-21
16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30

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

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 2870.069

---

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

Table 2.
Use of Core Grid Plate Locations

Location	Hours
B-2	0.300
B-3	0.667
B-4	1.133
B-6	0.483
B-7	0.083
C-2	0.400
C-3	0.900
C-4	1.300
C-5	1.483
C-7	2.700
C-8	0.483
C-9	0.067
D-2	0.700
D-3	0.567
D-5	1.200
D-6	0.400
D-7	0.233
D-8	1.217
D-9	0.733
E-3	0.167
E-5	0.167
E-7	0.167
E-8	0.550
F-3	0.800
F-7	0.167
Total	17.067

Table 3.

Facility Use Other Than the Reactor

Facility	Hours
Neutron Chopper	-
Bare Rabbit Tube	2.867
Cadmium-Lined Rabbit Tube	0.450
Beam Port	2.950
Reactor Console	289.0
Thermal Column	-
Total	295.267

Table 4.

Reactor Utilization

Reactor use	(hr)	1328.0
● Research runs	(hr)	7.4
● Instruction runs	(hr)	1307.25
● Maintenance runs	(hr)	13.35
Maintenance (reactor shutdown)	(hr)	848.0
Time at power	(hr)	115.0
Heat generated	(kW hr)	2093.7
Total number of samples		289.0
Sample hours	(hr)	41.9
Research & Instruction usage(1)	(%)	63.2
U-235 burned	(g)	0.091
U-235 burned and converted	(g)	0.108

---

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

Table 5.

Scrams and Rundowns

Date	Event
4-21-82	Rundown, 120% demand, dirty contacts on switch.
4-22-82	Rundown, 120% demand, caused by slow movement of switch.
4-22-82	Rundown, 120% demand, caused by switching scales in wrong direction.
5-3-82	Scram, intentional for training.
5-6-82	Scram, intentional for training.
5-26-82	Rundown, Hi Rad. setpoint set at approximately 8 mr. Radiation level indicated approximately 8 mr on RAM system.
5-30-82	Rundown - Bldg. Evacuation for training.
6-14-82	Scram, intentional because of reactivity worth of sample holder used. We did not want to move it with reactor at power.
6-25-82	Scram, intentional for training.
7-01-82	Scram, intentional for training.
7-07-82	Rundown, Hi Rad. caused by spurious signal when rods were at 17".
8-09-82	Rundown, Hi Rad. indicated 10 mr above pool, SRO checked and found 5 mr above pool. RAM reading high.
8-10-82	Rundown, Hi Rad. for training.
9-22-82	Rundown, Hi Rad. building evacuation for training.
10-12-82	Rundown, 120% demand due to spurious signal on Log N amplifier.
10-14-82	Scram, caused by spurious signal in Log N amplifier.
10-14-82	Scram, caused by spurious signal in Log N amplifier.
11-02-82	Rundown, due to void tube motion.
11-02-92	Rundown, due to void tube motion.
11-02-82	Rundown, due to void tube motion.
11-03-82	Rundown, due to void tube motion.
11-09-82	Rundown, caused by Hi Rad. at demineralizer.
11-09-82	Rundown, caused by Hi Rad. at demineralizer.
11-30-82	Rundown, building evacuation due to student removing sample too close to detector.

Table 5, continued.

Date	Event
1-27-83	Scram, spurious signal in period amplifier.
2-01-83	Rundown, 120% demand, turned micro-micro ammeter switch wrong way.
2-02-83	Rundown, 120% demand, operator error, turned micro-micro switch wrong way.
3-01-83	Rundown, 120% demand. Log N and safety indicated proper power level.

Table 6.

Maintenance

Date	Event and Corrective Action
4-23-82	Replaced micro-micro ammeter (linear) after bench checking because of erratic meter indication.
5-10-82	RAM (beamroom) not operational.
5-18-82	Rod drop and separation time verification.
5-25-82	Power calibration check.
5-26-82	Temperature coefficient check.
6-11-82	RAM #3 not indicating - Transistor Q3 bad.
6-21-82	Power calibration adjustment of CIC according to power calculations.
7-01-82	Magnet #2 shorted. Changed and rewound magnet.
7-07-82	Magnet #2 shorted. Changed and rewound magnet.
7-14-82	Rod inspection (annual).
8-02-82	Change resins.
8-03-82	Change resins.
8-10-82	Replaced broken belt on bay air conditioner.
8-26-82	Changed broken valve #19 on pool line.
8-31-82	Removed and replaced micro-micro ammeter for semi-annual.
8-31-82	Intermediate level RAM reading 10 mr/hr. Shield inside detector not shielding source.
10-01-82	Micro-micro ammeter pegged high. Removed and replaced micro-micro ammeter.
10-19-82	Removed and replaced micro-micro ammeter. Meter would not zero.
11-16-82	Temperature recorder erratic. Cleaned & repaired.
11-24-82	Set point on linear recorder drifts. Lubricated and adjusted clutch.
12-20-82	Rod drop verification.
12-22-82	Fire alarm checked.
12-29-82	Repaired RAM detector by demineralizer.
12-29-82	Auto controller not operating. Caused by mismatch between setpoint and indicator.

Table 6, continued.

Date	Event and Corrective Action
1-10-83	Completed Semi-annual checks on Log N power supply drawer, linear power supply, counter-scaler, safety amplifier, Log N amplifier, period amplifier, log count rate amplifier, temperature recorder, spare PAT 60 Auto controller.
1-18-83	Log count rate aligned.
1-19-83	Removed micro-micro ammeter for semi-annual check.
1-20-83	Aligned Log N amplifier for semi-annual maintenance.
2-04-83	Rod #1 indicator slipping down. Brake failed on rod drive.
2-04-83	Lock ring on Rod brake #1 came off. Replaced.
2-10-83	Replaced pilot light on core light switch.
2-18-83	Adjusted setpoint and marker on linear recorder.
3-07-83	Log N slow to respond on calibration check. L_1 bad on Log Modulator Board.
3-22-83	Changed both pressure gauges on pool line.
4-01-83	Replaced broken pipe on sump pump.

Table 7.

Core Loading and Unloading

Date	
4-16-82	Loading core to 67W following notification that two of the staff had passed the SRO examination.
7-13-82	Unloading core to subcritical for purpose of inspecting the control rods.
7-13-82	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	$1.6X10^{12}$ n/cm^2-sec at 200 kW
Maximum Thermal Flux	$2.8X10^{12}$ n/cm^2-sec at 200 kW
Average Epithermal Flux	$1.6X10^{11}$ n/cm^2-sec at 200 kW
Worth of Thermal Column	0.38%
Worth of Beam Port	not detectable

Rod Worth (in "T" mode)

Date 4-16-79	4-16-79	4-16-79	12-19-78
I 2.64%	II 2.65%	III 3.36%	Reg. 0.347%

Excess Reactivity (in "T" mode) 0.72% Shutdown Margin (in "T" mode) 4.57%.

Void Coefficient $-3.7X10^{-7} \rho/cm^3$ Date 12-20-82 Limit $-2.0X10^{-7} \rho/cm^3$

Temperature Coefficient $-9.3X10^{-5} \rho/°F$ Date 12-7-82 Limit $-4.0X10^{-5} \rho/°F$

Xenon-free temp. coeff. $-1.38X10^{-5} \rho/°F$ Date 11-24-82

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

I 0.019 II 0.019 III 0.026 Reg. 0.01

Rod Drop Time (24")

I 490 msec, II 490 msec, III 500 msec, Date 12-20-82

Magnet Separation Time

I 20 msec, II 32 msec, III 24 msec, Date 12-20-82

VI. Public Relations

The reactor staff continues to put forth considerable effort to help educate the public about the application of nuclear energy. Over 2,170 persons have toured the facility during this report period. This is an increase of 14% 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 groups from other universities 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 sued in the industrial and educational fields and how nuclear energy helps the environmental situation.

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 42 UMR students, graduates and undergraduates, have participated in classes at the facility, utilizing 71 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 304 Reactor Laboratory I	90.4
NE 306 Reactor Operations	123.3
NE 308 Reactor Laboratory II	70.2
Reactor Operator Training Program	52.0
Preliminary Research	5.0

The current enrollment in Nuclear Engineering is 78 students. During this reporting period the reactor was used 98.4% for instruction 0.6% for research, and 1% for maintenance.

A pilot educational program was performed (March 83') for graduate students of the Nuclear Engineering Department of the University of Arkansas, Fayetteville consisting of some advanced reactor and irradiation experiments. Also a possibility for neutron dosimetry experiments was explored.

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, 5 shipments of by-product material were surveyed and released from the reactor facility. Total activity released was 649.2 mCi. Two of the shipments were off campus which accounted for 2.0 mCi of the total activity. The other 3 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. Sixteen 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 27 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 1.68×10^{-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 6.16 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 10 releases to the sanitary sewer totaling approximately 3,995 gallons of concentrated resin regeneration solution and pool water were discharged with a total activity of 0.076 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

During the future reporting period the reactor staff intends to complete replacement of some of the origionally installed, control room instrumentation. The final items to be purchased consist of two compensated ion chamber power supplies for the linear and log-N intermediate range nuclear instruments. The source range magnet power supply, and power range equipment has been previously purchased and needs to be installed.

The Facility is still involved in a re-licensing effort that began in November of 1979. We have been informed by the NRC that their review of the initial facility documents will be completed and the resulting questions/answer series will begin shortly.

An expansion of the number of the reactor staff members who are licensed senior operators to at least three is planned. This should allow the facility to expand its operation without increase in operating costs to the University.

It is hoped that the reactor will participate in the University Reactor Sharing Program sponsored by the Department of Energy. This program provides funds to pay for student instruction and research performed for the universities and colleges which do not have a reactor facility of their own.

APPENDICES

APPENDIX A

JU' 1 1982 rec'd + read

REACTOR FACILITY INSPECTION -- Date(s) May 27, 28, 1982
(Phone: 341-4236)

Date(s) of last NRC inspection None {NRC was concerned about personnel changes. Reactor shut down for one month

Date(s) of last "inhouse" inspection Oct 21, 22, 26, 1981

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	5	142	Bottom of page (Oct 21, 1981) {9:30
Through entry:	5	224	May 26 (Start with first entry) 9:55

Follow up items from previous inspection (item; follow-up):
Is reactor operating under a temporary license? Yes. NRC is aware of this.
Check on pool wall paint — stable
Log book accuracy — needs attention

	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 $60^{\circ}F < t < 135^{\circ}F$ ----------------	✓	78° outlet 81°
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 Triga (Beam room) Present loading(s):
(4.1.3) $\rho_{ex} < 1.5\%$ --------------	✓	
$1.5\% < \rho_{ex} < 3.5\%$ five consecutive days twice a year ---------------	✓	Sr. Oper. ~~Dates~~: (1) other method (2) used
7. Control rod: (9.5) condition ----	✓	Date inspected:
(4.2.3) Reactivity shutdown margin at least 8% --------------	✓	Annual July 28, 1981
*(4.2.4) Drop time < 600 msec -----	✓	(9.3) Dates: (1) May 20, 1982 (2)
(4.3.2) Limit lights; shim range lights; magnet contact lights ----	✓	one not operative - procedure ok
8. Neutron source (min. 10^6 n/sec) --	✓	

* See Semi-annual check list p. 9

	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 Near demineralizer — Beam room — Checked during start-up
12. (5.8) Portable survey instruments List:	✓	
Neutron		Alpha
Gamma See attached sheet p.		Beta
Other		
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: $\rho_{ex} < 0.4\%$	✓	
ρ_{ex} 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	✓	
(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)	✓	Reactor unloaded for one month
(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.	✓	* Observed start-up
150% full power	✓	startup May 27, 1982
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	✓	OK
(9.3) Instrument channels & area monitors-calibrated at 90 day intervals	✓	Dates: (1) Kept by Health Physicist See p 8 (2) (3) (4)
UMRR startup check list	✓	
Hourly records-note variations	✓	
Shut-down check list	✓	
Weekly check list	✓	
Work load log	x	N.A.
Six month systems check	✓	Dates: (1) Started Dec 10, 1981 (2) Needs to be done shortly. G
UMR Reactor Irradiation Request	ok	

	OK	Comments
B. Records		
1. Log books	✓	Current book number 5 Other 1-4 Stored in Bldg
2. Recorder charts	✓	Stored: where and for how long
Log N (permanent)	✓	Located: Head of stairs (2 years)
3. Evacuation alarms: number and cause	✓	None 2.
4. Evacuation procedures, drills	✓	— Feb 25, 1982 at 1323 – Bldg alarm
5. Use of by-pass keys	✓	1. none
6. Key security	✓	
General security	✓	
Night use of building	✓	yes — checked with police
7. SOP'S - Note any revisions	✓	In process, when completed needs to be checked
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)	x	
D. Control Room	✓	Also see Operator Requalification page 9 of this report
List of current operators	✓	Senior operators: M.R. Middleton — Apr 6, 1982 A. E. Bolon — Apr 6, 1982 Operators: K. J. Lane May 4, 1981 C M Barton June 11, 1980 D. 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	✓	
1. Thermal column	✓	
2. Beam tube	✓	
3. Fuel storage	✓	
4. Liquid & solid waste storage	✓	
J. Health Physics		
1. Sample removal	✓	
2. SOP'S (list)	OK	
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	✓	none
6. Radiation survey	✓	Dates: See Health Physics and p. 8
a. Periodic swipe tests	✓	
b. Pool water	✓	
c. Inside air	✓	
d. Outside air	✓	
e. Neutron level (sub-critical	✓	
f. Misc. items (list)	✓	
7. Emergency box (Physics Bldg.)	✓	OK

General comments:

The availability of records both current and past is much improved. I generally call for records to the previous inspection. For the most part the records were up to date and complete. Some specific dates in the requalification records have not been kept up or have not been entered. General evaluation dates on some of the records are in the lower right hand corner. Afolder for Dan Carter needs to be prepared.

Because of the rather sudden change in administrative personnel a smooth transition was not possible. It now becomes necessary to have what I would call, "An On-hands Acquaintance Period." The teaching and training schedule for the summer may very well be light, giving time for adjustments. Also the semi-annual check is coming up. I would suggest that the staff meet often and get things squared away by the time the fall semester starts.

Items that I think need special attention are:

(1) The log book. It would be well to review as to what should go into the log. Also emphasize accuracy. The following are examples. On page 150 (bottom) the entry states that the reactor was in 67T mode. Next page (151) it states the the reactor was placed in the "T-mode". In between these two entries the reactor must have been in the "W-mode", but this is not recorded. On page 160ff it is not clear what the 18 is and on page 163 the 81. On page 181 some information was missing (red entry is mine). It is necessary to have some duplication of records, log book versus start-up, hourly check and shut down. It is easy to forget one or the other. Dr. Tsoulfanidis suggested that a terse statement of the purpose of the run be added. Also be sure to fill in all information. See illustrations at the bottom of this page. Somewhere there should be an explanation of letters. This could be posted or placed on the inside cover of the log book. Examples: UE 18, LM1, NRF4.

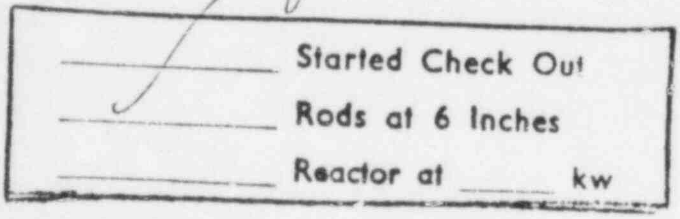
(2) Develop a summer schedule to dovetail, the semi-annual check with the requalification and the control rod inspection.

(3) Discuss setting up a schedule for checking items (surgical gloves, etc.), in the emergency box, for deterioration (shelf life).

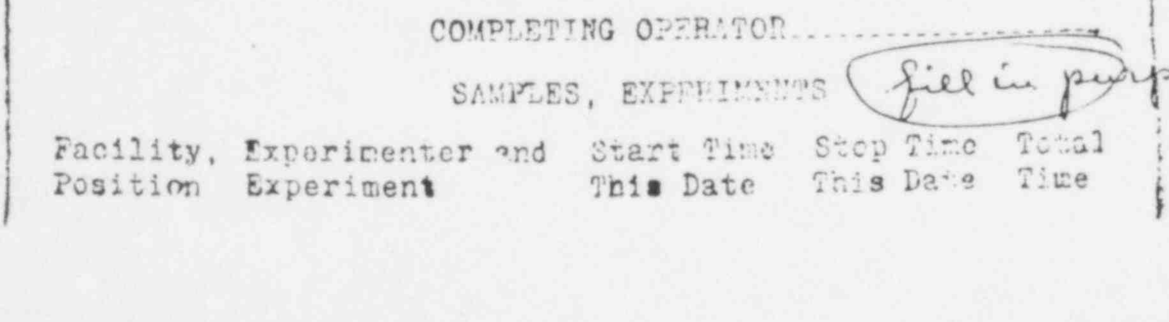
May 29, 1982 Signed: Franklin B. Pauls

Copies to:
Dr. A. E. Bolon
Dr. N. L. Gale

fill in completely


_______ Started Check Out
_______ Rods at 6 Inches
_______ Reactor at _____ kw

UE 18
Observation of reactor start-up


DATE................ FIRST OPERATOR.................

COMPLETING OPERATOR.................

SAMPLES, EXPERIMENTS fill in purpose!

Facility, Position	Experimenter and Experiment	Start Time This Date	Stop Time This Date	Total Time

& all other

Special Nuclear Materials (SNM)

Position Name

Reactor Director Dr. A. E. Bolon

Reactor ~~Supervisor~~ Manager ------------

SNM Custodian M. R. Middleton

1. (See p. 2) Procedures reviewed annually by the Reactor Supervisor:
   Date Name
   Needs to be reviewed

2. SNM Records: Where kept? In file in main office

   (1) Position and/or change of position of non-irradiated fuel: No

   (2) Position and/or change of position of irradiated fuel: No

   (3) SNM receipts: none } reported to NRC 4/23/82

   (4) SNM shipments: none }

   (5) Semi-annual Material Status Report:
   Most recent previous report: Date __________
   Current report:
   Date __________

   (6) Annual Physical Inventory (SNM status log):
   Date April 23, 1982
   Previous report: X

   Current report: OK

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

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

   (9) SNM Internal Control Areas:

   Dry storage area (basement): OK

   Reactor: OK

   Containment building: OK

Fuel Inventory: Oct 23, 1981
MTR & Triga Apr 23, 1982

Fuel Burn-up
(NRC) Material Balance Report Apr 23, 192
also UMRR - Fuel Inventory Mar 31, 1982

UNIVERSITY OF MISSOURI-ROLLA

Radiation Safety Office
Building C
Rolla, Missouri 65401
Telephone: (314) 341-4240

January 17, 1980

MEMO TO: D.R. Edwards and A. Elliott

FROM: Ray Bono and N. Tsoulfanidis

RE: UMR Monthly Reactor Health Physics Audit

On January 4, 1980, we performed an audit of Reactor Health Physics activities. We checked the frequency as well as the method used in carrying out the following activities:

Function	Frequency
1. Swipe test of sealed sources	6 months — 11/23/81 & 5/13/8
2. Radiation area monitor (RAM) calibration	quarterly 12/11/81 & 3/16/82
R ~~3. Health Physics instrument calibration~~	-quarterly - Ok Read in May
4. Swipe test of reactor building - - - - - - - -	monthly ——— Ok
R ~~5. Air releases~~ - - -	monthly 3/82
6. Water releases	regeneration - 3/2/82 &
7. Building survey	monthly - 5/82
8. Routine pool water analysis	monthly - 5/12/82
B'-9. By-product material released	monthly - 5/ /82
10. Pool water tritium ana.	6 months - Dec, 1981

1. Sealed Sources. There are eight sealed sources requiring a leak test every six months. The last leak check was performed by Ray Bono in November 1979. All eight sealed sources are due to be leak tested again in May 1980.

2. RAM Calibration. The records show that the calibrations have been performed on schedule but in one case, there is a five month gap between the first and second quarter of 1979. The activity recorded for the source used for calibration should be the activity at the time of calibration.

3. Health Physics instrument calibration. This is done on a quarterly basis at the Reactor. Copies of all surveys and instrument calibrations should be forwarded to the Health Physics office upon completion. Meter calibrations are in order but a few calibration sheets do not indicate the scale used. Scale used should be recorded.

(Don't just say mr/hr, be sure to give the upper limit of the scale for all meters.)

Enclosed is a copy of the U.S. NRC Regulatory Guide Revision 1, October 1979, which should be followed when calibration are performed. The G.M.

Operator Requalification During License Period

Training Coordinator: ______

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

Name of Operator	License number and date	~~Exam dates~~ Lectures	Comments	5-year record
1. A. E. Bolon Senior	Apr 6, 1982	May 19, 20, 21		
2. M. R. Middleton Senior	Apr 6, 1982	absent		
3. K. G. Lane	May 4, 1981	Exam 6/81 5/4/81 → 5/4/82		
4. C. M. Barton	June 11, 1980	Exam 6/81		
5. D. Carter	Apr 6, 1982			

B. Performance Evaluation (Semi-annual)

Name of Operator	Evaluation Date	Comments
1. A. E. Bolon Senior	In progress	
2. M. R. Middleton Senior	10/81 In progress	
3. K. G. Lane	10/22/81	
4. C. M. Barton	6/11/80 — 6/11/81 6/11/81 — 12/11/81	
5. D. Carter	In progress	
6.		

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

Name of Operator	Annual Summary Date	Comments
1. M. R. Middleton Senior	In progress	
2. A. E. Bolon Senior	In progress	
3. K. G. Lane	5/4/81 → 5/4/82	
4. C. M. Barton	Last ~~5/5/81~~ 6/11/82	
5. D. Carter		
6.		

UNIVERSITY OF MISSOURI

Research Reactor Facility

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

January 26, 1983

JAN 28 1983

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

Dear Dr. Bolon:

On Wednesday, December 15, 1982, Walter Meyer and I conducted a Reactor Facility Inspection of the UMR-Reactor. The completed inspection form is attached for your records.

Due to performing the inspection in one day, not all areas were covered. The areas not covered are noted on the inspection form and this should be brought to the attention of the next inspector(s). It is suggested that future inspections not be scheduled during finals week; this resulted in only 2 to 3 hours available to question responsible individuals other than C. M. Barton, who was very helpful in reviewing his area. We want to thank you and your staff for being very helpful in finding and explaining your records.

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

COLUMBIA KANSAS CITY ROLLA ST. LOUIS

an equal opportunity institution

REACTOR FACILITY INSPECTION -- Date(s) December 15, 1982
(Phone: 341-4236)

Date(s) of last NRC inspection Not checked

Date(s) of last "inhouse" inspection May 27 & 28, 1982

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	5	224	May 26
Through entry:	5	268	Dec 14, 1982

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

Log book accuracy
Revision to SOP
Emergency supplies

	OK	Comments
A. Technical specifications-------------- Appendix A -- Jan. 6, 1967	✓	Some confusion on what is "current" Tech Specs
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) ________ (2) ________
(4.3.2) Limit lights; shim range lights, magnet contact lights-----	✓	
8. Neutron source (min. 10^6 n/sec----		

not looked at due to time limited

	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	not performed	Location / Reading
		Pool surface above core
		Near demineralizer
		Beam room
12. (5.8) Portable survey instruments List:		
Neutron Victoreen 488A	✓	Alpha
[illegible] III 2035	✓	
Gamma G-M - #997 Eberline E-120 (γ)	✓	Beta
Eberline RM-14 βγ	✓	
#394 Eberline E-120 γ	✓	
Other #1797 PIC-6A	✓	
#1851 PIC-6A	✓	
13. Experimental facilities----------- 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: 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.--		Give example as to how it is used. It is the auditor's view that this area is in need of some improvement. There was difficulty in finding the documentation authorizing some of the in pool irradiations. Additionally ~~an experiment~~ it was not clear that the reactivity worths of all experiments were being evaluated. (June 14 & 19, 1982).
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)-----	✓	This was being met, but it is suggested for your consideration that you look at documenting in your operating log who is the "on duty" SRO and RO. This makes it very clear who needs to be relieved before leaving the facility.

	OK	Comments
15. Fuel Storage & Transfer wall chart ----------------------	←	we did not verify accuracy;
(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)------	N/A	
(10.2) Core configuration change: one grid position. (Reason & date)	N/A	
(10.3) Loading change of more than one grid position-unload 50%------	✓	
17. Instruments functioning (Table I)-		(On weekly check list - *)
Scram: Manual-------------------	✓	startup reviewed by checking startup and weekly check lists Weekly check list form (811) that was being used had no revision date but Form 811 in SOP had a revision date. Similar situation on forms 104 & 105
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 ? intervals------------------------	✓	Dates: (1)________ (2)________ (3)________ (4)________
UMRR startup check list-----------	✓	
Hourly records-note variations----	✓	
Shut-down check list--------------	✓	
Weekly check list-----------------	✓	
Work load log---------------------	NA	
Six month systems check-----------	✓	Dates: (1)________ (2)________

	OK	Comments
B. Records		
1. Log books	✓	Current book number 5 Other ____ Stored ____
2. Recorder charts	✓	Stored: where and for how long
Log N (permanent)	✓	Located:
3. Evacuation alarms: number and cause	✓	1. Number of Evacuation 2. alarms and drills was
4. Evacuation procedures, drills	✓	1. not noted but their
5. Use of by-pass keys	not look at	occurrance and corrective
6. Key security		action was duly note in
General security		log book.
Night use of building		
7. SOP'S - Note any revisions	✓	Confusing to an outsider to determine what was the current revision for SOP Procedures and forms.
8. Film badge, dosimeter		not checked
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: LICENSE DATE RECAN R.E. [illegible] 4/6/82 M.R. [illegible] 4/6/82
E. Office (film badge rack, etc.)	✓	
F. Counting Room	✓	Operators: K.C. [illegible] 5/4/81 5/28/82 C.M. Bruton 6/11/80 5/28/82 R. [illegible] 4/6/82
G. Rooms & Storage upstairs	✓	
H. Review	→	reviews needed to keep on-the-job training performance evaluations up to date. Appeared to be some evaluation periods missed for several operators.

	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		not checked Health Physicist did not participate in this audit.
2. SOP'S (list)		
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		
e. Neutron level (sub-critical		
f. Misc. items (list)		
7. Emergency box (Physics Bldg.)		← not checked

General comments:

The overall operations are good but the focus of an audit or inspection is to identify weaknesses—not strengths; therefore this must be kept in mind when reviewing the comments. Additionally the follow up item concerning Log Book accuracy has improved but is still an area that could use improvement.

Sincerely
Charlie McKibben
Walter Meyer

APPENDIX B

Semi Annual Check List

Date Commenced 12-10-81

Date Completed ~~[illegible]~~ 20 Jan ~~81~~ 82

Total Hours on Hour Meter 7942.6

Vacuum Tube Test and Clean Chassis — Initial

a. Log N Power Supply

(1) Cleaned chassis — JAN 23 1982

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

None

b. Linear Power Supply

(1) Cleaned chassis — JAN 23 1982

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
V3	5651
V4	5651
V10	5651

(3) Additional Comments

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

2. Additional Comments

D. Log N

1.

Meter	Recorder	Keithley	Initial
100	120	$5X10^{-5}$	CMS
10	8	$3.4X10^{-6}$	CMS
1	0.9	$3.6X10^{-7}$	CMS
0.1	0.15	$5X10^{-8}$	CMS
.01	0.015	$5.6X10^{-9}$	CMS
.001	0.0018	$6.0X10^{-10}$	CMS
.0001	0.0002	$5.0X10^{-11}$	CMS

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

a.

Rod #	Rod Height (inch)	Separation Time (< 50 msec)	Rod Drop Time (< 600 msec at 24")
1	6	37 ms	280 ms
1	12		350 ms
1	18		440 ms
1	24		490 ms
2	6	30 ms	300 ms
2	12		405 ms
2	18		445 ms
2	24		490 ms
3	6	34 ms	290 ms
3	12		375 ms
3	18		450 ms
3	24		510 ms

b. Date performed MAY 20 1982 Preformed by CMS

Director or Supervisor REBoton

6. Void Coefficient Determination

a. Value of void coefficient $-4.68 X10^{-7}$ $\frac{\Delta K/K}{cm^3}$ ΔK/K/cm^3 ✓

b. Calculation performed by AEBolon

c. Date performed MAY 21 1982

d. Director or Supervisor AEBolon

7. Temperature Coefficient Determination

a. Value of temperature coefficient $-13.4 X10^{-5}$ ΔK/K/°F

b. Calculations performed by AEBolon

c. Date performed 5/26/82

d. Director ~~or Supervisor~~ AEBolon

8. Rod Speeds

Time (Sec)	I.	II.	III.	Reg.
0-24"	241.1	240.6	239.5	62.1

FEB 1982 CMB

(3) Additional Comment

Date FEB 4 1982 Performed By CMB

9. Rod Indicator Calibration

Actual Height	Indicator Reading I.	II.	III.	Reg.
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

Date May 28 1982

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

A.E. Bolon

Semi Annual Check List

Date Commenced AUG 16 1982

Date Completed 12/20/82

Total Hours on Hour Meter 08142.6

. Vacuum Tube Test and Clean Chassis — Initial

a. Log N Power Supply

(1) Cleaned chassis

(2) Tested all vacuum tubes — AUG 16 1982

Replaced:

tube #	tube type
None	

(3) Additional Comments

None

b. Linear Power Supply

(1) Cleaned chassis

(2) Tested all vacuum tubes — AUG 16 1982

Replaced:

tube #	tube type
None	

(3) Additional Comments

None

c. Linear Pulse Amplifier AUG 16 198

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

N/A

tube #	tube type

(3) Additional Comments

~~None~~ Replaced with Solid State

d. Scaler Timer AUG 16 1982

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
V3	12AT7

(3) Additional Comments

None

e. Safety Amplifier AUG 16 1982

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
V1	6CD6

(3) Additional Comments

None

f. Area Radiation Monitor — CWB AUG 6 1982

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

N/A

(3) Additional Comments

Replaced with Solid State

g. Micro-Micro Ammeter — CWB AUG 6 1982

(1) Cleaned chassis — CWB

(2) Tested all vacuum tubes

Replaced: tube # tube type

None

(3) Additional Comments

h. Fission Preamp — CWB AUG 6 1982

(1) Cleaned chassis and inspected — CWB

(2) Additional Comments

i. Public Address System

AUG

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

N/A

(3) Additional Comments

Replaced with Solid State

j. Log Count Rate Recorder

AUG

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

None

(3) Additional Comments

None

k. Linear Recorder

AUG

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

None

(3) Additional Comments

None

l. Period Recorder

AUG

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

None

(3) Additional Comments

None

m. Log N Recorder

AUG

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

None

(3) Additional Comments

None

n. PAT 60

AUG 16 1982

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

(3) Additional Comments

None

o. Regulated Power Supply

(1) Cleaned chassis

(2) Tested all vacuum tubes

AUG

Replaced: tube # tube type

(3) Additional Comments

Replaced with Solid State

p. Conductivity Brigge

(1) Cleaned chassis

(2) Tested all vacuum tubes

AUG 16 1982

Replaced: tube # tube type

Replaced with Solid State

q. Safety Amp Preamp

(1) Cleaned chassis

(2) Tested all vacuum tubes

AUG 16 1982

Replaced: tube # tube type

None

(3) Additional Comments

None

AUG 20 1982

2. Relay Test

   a. Console relays tested and replaced as per SOP 815

   b. Additional Comments

3. Detector Resistance

   a. Safety #1 — Value

      (1) Signal to ground 1.1×10^{11}

      (2) Positive to ground 3.6×10^{11}

      (3) Additional Comments

   b. Safety #2 — Value — Initial

      (1) Signal to ground 3.1×10^{11}

      (2) Positive to ground 3.7×10^{11}

      (3) Additional Comments

   c. Log N

      (1) Signal to ground 5×10^{10}

      (2) Positive to ground 7.2×10^{11}

      (3) Negative to ground 7.1×10^{11}

      (4) Additional Comments

   d. Linear

      (1) Signal to ground 1.7×10^{10}

      (2) Positive to ground 3.2×10^{11}

      (3) Negative to ground 1.4×10^{11}

      (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

1. Reading # / Thermometer / Recorder

Reading #	Thermometer	Recorder
1	80°F	80°F
2	80°F	80°F
3	80°F	80°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
	135°	CMB

B. Log Count Rate Channel

1. Pulse Generator*	Meter	Recorder	Initial
10	10'	10	CMB
100	120	130	CMB
1000	1200	1200	CMB
10,000	13000	10000	CMB

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

2. Additional Comments

C. Linear

1. Keithley	Meter	Recorder	Initial
$6.66X10^{-5}$	6.66	100	CMB
$2.0X10^{-5}$	2.0	100	CMB
$6.66X10^{-6}$	6.70	100	CMB
$2.0X10^{-6}$	2.0	100	CMB
$6.66X10^{-7}$	6.8	101	CMB
$2.0X10^{-7}$	2.0	100	CMB
$6.66X10^{-8}$	6.66	100	CMB
$2.0X10^{-8}$	2.05	101	CMB
$6.66X10^{-9}$	6.66	100	CMB
$2.0X10^{-9}$	2.0	100	CMB
$6.66X10^{-10}$	6.66	99	CMB
$2.0X10^{-10}$	2.0	100	CMB

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

S.N. 19083 removed from console

C. Linear

1.

Keithley	Meter	Recorder	Initial
$6.66X10^{-5}$	6.60	100	CMB
$2.0X10^{-5}$	2.0	~~2.0~~ CMB 100	CMB
$6.66X10^{-6}$	6.8	101	CMB
$2.0X10^{-6}$	2.0	100	CMB
$6.66X10^{-7}$	6.67	101	CMB
$2.0X10^{-7}$	2.05	101	CMB
$6.66X10^{-8}$	6.60	100	CMB
$2.0X10^{-8}$	2.0	100	CMB
$6.66X10^{-9}$	6.7	100	CMB
$2.0X10^{-9}$	2.0	101	CMB
$6.66X10^{-10}$	6.66	104	CMB
$2.0X10^{-10}$	2.0	98	CMB

AUG 24 1982

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

Keithley S.N. 19650 placed in console for service.

D. Log N

1.

Meter	Recorder	Keithley	Initial
100	100	$5.0X10^{-5}$	CMB
10	7	$4.1X10^{-6}$	CMB
1	0.8	$4.0X10^{-7}$	CMB
0.1	0.1	$5.0X10^{-8}$	CMB
.01	~~6.0~~ cmb 0.01	~~[illegible]~~ $6.0X10^{-9}$	CMB
.001	0.001	$7.0X10^{-10}$	CMB
.0001	0.0001	$5.0X10^{-11}$	CMB

AUG

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

a.

Rod #	Rod Height (inch)	Separation Time (< 50 msec)	Rod Drop Time (< 600 msec at 24")
1	6	19.25	280
1	12	|	360
1	18	|	430
1	24	↓	490
2	6	32.0	270
2	12	|	355
2	18	|	430
2	24	↓	490
3	6	23.5	290
3	12	|	370
3	18	|	440
3	24	↓	500

b. Date performed 12/20/82 Preformed by

Director ~~or Supervisor~~ D.E. Boston

6. Void Coefficient Determination

a. Value of void coefficient -3.72×10^{-7} % ΔK/K/cm^3

b. Calculation performed by Ray Hirsch, Don Hansen, Chris Pavloski

c. Date performed 12/20/82

d. Director ~~or Supervisor~~ R.E. Bolon

7. Temperature Coefficient Determination

a. Value of temperature coefficient -9.29×10^{-5} % ΔK/K/°F

b. Calculations performed by Keith Hook

c. Date performed 12/7/82

d. Director ~~or Supervisor~~ R.E. Bolon

8. Rod Speeds

Time (Sec)	I.	II.	III.	Reg.
0-24"	240	239.2	238.4	60.8

(3) Additional Comment

Date SEP 23 1982 Performed By AMB

9. Rod Indicator Calibration

Actual Height	Indicator Reading I.	II.	III.	Reg.
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"

SEP 23 1982
AMB

10. Results of Annual Control Rod Inspection

A. Control Rod Number 1

Top of rod 6 mr/hr on contact. Middle of rod 60 mr/hr on contact. Bottom of rod 5 r/hr on contact. Control Rod #1 looks fine. Top of rod magnet contact face clean and tightly mounted. No apparent changes, No cracks or new pitting

11.b Control Rod Number 2

Top of rod 10 mr/h on contact. Middle of rod 100 mr/h on contact. Bottom of rod 8 r/h on contact. Cleaned magnet contact face with an emery cloth, some rust was removed. Control rod #2 is straight and clean, no major pitting.

11.c Control Rod Number 3

top of rod 9 mr/hr on contact. Middle of rod 90 mr/hr on contact. Bottom of rod 8 r/hr on contact. Cleaned magnet contact face with emery cloth, some rust were removed. Several deep pitts remain on magnet contact face. There is a 0.060" bow at center of rod.

Inspection was accomplished by Prof. Robert Wolf and the Reactor Staff. Health physics coverage by Ray Bono. Max. dose received was 7 mr, waist, 5 mr chest by Robert Wolf.

d. Date Performed Jul 15 1982

e. Director ~~or Supervisor~~ A. E. Bolon

Date Dec. 30 19 82

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

A.E. Bolon

Semi Annual Check List

Date Commenced JAN 10 1983

Date Completed ____________

Total Hours on Hour Meter 8246.6

1. Vacuum Tube Test and Clean Chassis — Initial

a. Log N Power Supply

(1) Cleaned chassis — CMB JAN 1983

(2) Tested all vacuum tubes — CMB

Replaced:

tube #	tube type
V 2	5651
V 4	5651
V 5	5651
V 7	5651
V 8	5651

(3) Additional Comments

None

b. Linear Power Supply

(1) Cleaned chassis — CMB JAN

(2) Tested all vacuum tubes — CMB

Replaced:

tube #	tube type
V 7	5651
V 8	5651

(3) Additional Comments

c. Linear Pulse Amplifier

(1) Cleaned chassis ______

(2) Tested all vacuum tubes ______

Replaced:

Removed from Service

tube #	tube type

(3) Additional Comments

None

d. Scaler Timer

(1) Cleaned chassis CW 1/13 JAN 1[illegible] 1983

(2) Tested all vacuum tubes CW 1/13

Replaced:

tube #	tube type
None	

(3) Additional Comments

e. Safety Amplifier

(1) Cleaned chassis CW 1/13 JAN 1[illegible] 1983

(2) Tested all vacuum tubes CW 1/13

Replaced:

~~Removed from~~ CW 1/13

~~Service~~ CW 1/13

tube #	tube type
None	

(3) Additional Comments

f. Area Radiation Monitor

(1) Cleaned chassis JAN

(2) Tested all vacuum tubes *

Replaced:

tube #	tube type

* Replaced with Solid State

(3) Additional Comments

g. Micro-Micro Ammeter

(1) Cleaned chassis JAN

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

h. Fission Preamp

(1) Cleaned chassis and inspected

(2) Additional Comments

i. Public Address System

(1) Cleaned chassis ★

(2) Tested all vacuum tubes

Replaced:

tube #	tube type

★ Replaced with Solid State

(3) Additional Comments

j. Log Count Rate Recorder — CWB JAN 10 1983

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

k. Linear Recorder — CWB JAN 10 1983

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #	tube type
None	

(3) Additional Comments

l. Period Recorder

(1) Cleaned chassis

(2) Tested all vacuum tubes

1983

Replaced:

tube #	tube type
None	

(3) Additional Comments

m. Log N Recorder

(1) Cleaned chassis

(2) Tested all vacuum tubes

JAN 1983

Replaced:

tube #	tube type
None	

(3) Additional Comments

n. PAT 60

(1) Cleaned chassis

(2) Tested all vacuum tubes

JAN 1983

Replaced:

tube #	tube type
V2	12AY7
V3	5963

(3) Additional Comments

o. Regulated Power Supply

JAN 10 1983

(1) Cleaned chassis

X

(2) Tested all vacuum tubes

Replaced:	tube #	tube type

* Replaced with Solid State

(3) Additional Comments

p. Conductivity Brigge

JAN 10 1983

(1) Cleaned chassis

X

(2) Tested all vacuum tubes

Replaced:	tube #	tube type

* Replaced with solid state

q. Safety Amp Preamp

JAN 10 1983

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:	tube #	tube type
	None	

(3) Additional Comments

JAN 20 1983

2. Relay Test

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

   b. Additional Comments

      Replaced Relays 7, 8 Both are Recorder Ch5 relays

3. Detector Resistance

   Mar. 31, 83

   a. Safety #1 — Value

      (1) Signal to ground 10×10^{12} CWB

      (2) Positive to ground 1×10^{12} CWB

      (3) Additional Comments

   b. Safety #2 — Value — Initial

      (1) Signal to ground 10×10^{12} CWB

      (2) Positive to ground 1×10^{12} CWB

      (3) Additional Comments

   c. Log N

      (1) Signal to ground 2.2×10^{12} CWB

      (2) Positive to ground 3.5×10^{12} CWB

      (3) Negative to ground 0.31×10^{10} CWB

      (4) Additional Comments

   d. Linear

      (1) Signal to ground 3.6×10^{10} CWB

      (2) Positive to ground 5.2×10^{10} CWB

      (3) Negative to ground 0.75×10^{11} CWB

      (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

1.

Reading #	Thermometer	Recorder
1	80°F	
2	80°F	
3	80°F	
1	140°F	
2	140°F	
3	140°F	

Note: All readings should be ± 1°F

2. 135°F Interlock	Trip Point	Initial

B. Log Count Rate Channel

1.

Pulse Generator*	Meter	Recorder	Initial	
10	10	8	CMB	JAN 1 1983
100	100	80	CMB	JAN 1 1983
1000	1000	1000	CMB	
10,000	10000	10000	CMB	

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

2. Additional Comments C_1 and C_2, R_5, R_6 were bad C_1 and C_2 Replaced, R_6 pot. was substituted. Direct replacement will be ordered

C. Linear

1.

Keithley	Meter	Recorder	Initial
$6.66X10^{-5}$	6.66	100%	CMB
$2.0X10^{-5}$	2.0	100%	CMB
$6.66X10^{-6}$	6.66	101%	CMB
$2.0X10^{-6}$	2.0	100%	CMB
$6.66X10^{-7}$	6.70	101%	CMB
$2.0X10^{-7}$	2.0	101%	CMB
$6.66X10^{-8}$	6.60	100%	CMB
$2.0X10^{-8}$	2.0	100%	CMB
$6.66X10^{-9}$	6.66	101%	CMB
$2.0X10^{-9}$	1.96	100%	CMB
$6.66X10^{-10}$	1.95	99%	CMB
$2.0X10^{-10}$	1.90	98%	CMB

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

D. Log N

1.

Meter	Recorder	Keithley	Initial
100	100	5×10^{-5}	CMB
10	10	5×10^{-6}	CMB
1	1	4.0×10^{-7}	CMB
0.1	0.1	5×10^{-8} ~~5x10~~ [illegible]	CMB
.01	0.01	5×10^{-9}	CMB
.001	0.0015	5×10^{-10}	CMB
.0001	0.0002	5×10^{-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

a.

Rod #	Rod Height (inch)	Separation Time (< 50 msec)	Rod Drop Time (< 600 msec at 24"
1			
1			
1			
1			
2			
2			
2			
2			
3			
3			
3			
3			

b. Date performed ____________ Preformed by ____________

Director or Supervisor ____________

6. Void Coefficient Determination

a. Value of void coefficient ______________________ % ΔK/K/cm³
b. Calculation performed by ______________________
c. Date performed ______________________
d. Director or Supervisor ______________________

7. Temperature Coefficient Determination

a. Value of temperature coefficient ______________________ % ΔK/K/°F
b. Calculations performed by ______________________
c. Date performed ______________________
d. Director or Supervisor ______________________

8. Rod Speeds

Time (Sec)	I.	II.	III.	Reg.
0-24"				

(3) Additional Comment

Date __________ Performed By __________

9. Rod Indicator Calibration

Jan 7 1983

	Indicator Reading			
Actual Height	I.	II.	III.	Reg.
1"	1	1	1	1
6"	6	6	6	6
12"	12.1	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

11.b Control Rod Number 2

11.c Control Rod Number 3

d. Date Performed ______________________________

e. Director or Supervisor ______________________

Date ________________19________

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

____________________ ________________________

APPENDIX C

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: --
REVISED: Feb. 24, 1982
PAGE 1 OF 1

TITLE: Controlled Copies

1. Control room at UMRR
2. Foyer (outer office) at UMRR
3. Radiation Safety Officer, room 114, Nuclear Engineering Building

WRITTEN BY: Albert E. Bolon
APPROVED BY: Alva E Elliott

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.:	REVISED: 12-30-82	PAGE 1 OF 3

TITLE: Index

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.:
REVISED: 12-30-82
PAGE 2 OF 3

TITLE : Index

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.:	REVISED: 12-30-82	PAGE 3 OF 3

TITLE : Index

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 100 | REVISED: 12-30-82 | PAGE 1 OF 2

TITLE: Preamble

Only two copies of the SOP's are to be considered control copies. The controlled copies shall contain all approved procedures and will incoporate new or changed procedures immediately after they are approved. These controlled copies shall be retained in the office reception (Reactor Manager's Copy) and in the Control Room (Control Room Copy). All other copies of SOP's are to be considered complimentary only and shall not be used for any facility evolutions.

The Standard Operating Procedures provide written instructions for the routine and emergency operation of the Nuclear Reactor Facility. These procedures give the standard approved methods for carrying out each operation at the facility. For reference purposes, the SOP's are divided into the following sections by numbers

100 - 199	Routine Reactor Operation
200 - 299	Routine Facility Operation
300 - 399	Special Operations
400 - 499	Radioactive Wastes
500 - 599	Emergency Procedures
600 - 699	Radiation Protection
700 - 799	Reactor Utilization Forms
800 - 899	Reactor Instrumentation

If a situation arises which is not covered by one of the SOP's a new SOP shall be written and then approved by the Director of the Facility. If a situation arises where time does not permit the above procedure to be written, consult SOP 101.16 for changes in procedure.

The SOP's shall be reviewed periodically. The frequency of review shall be such that each SOP is reviewed once each year. The reviews will be made by either the RO's, SO's, RM or RD, and any recommendations for changes shall be discussed with the Reactor Manager. If, in turn, changes need to be made, a new SOP shall be written and approved through proper channels.

The distribution of the complimentary copies of the SOP's shall be at the discretion of the Reactor Manager. A listing of these individuals issued complimentary copies shall be maintained in the Reactor Manager's copy of the SOP's (front page).

Page 38, Section C, Paragraph 2 of the Hazards Summary Report states "The Director (of the Reactor Facility) will have the primary respon-

WRITTEN BY: KGL | APPROVED BY: A.E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 100	REVISED: 12-30-82	PAGE 2 OF 2

TITLE: Preamble

sibility of over-seeing all reactor activities. He shall make the final decisions relating to utilization of reactor time, feasibility of experiments, and operational procedures."

Therefore the Facility Director shall have the final authority to approve and put into service any Standard Operating Procedure.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 101 | REVISED: 12-30-82 | PAGE 1 OF 3

TITLE: General Operational Procedures

1. No one except a licensed operator may manipulate the reactor controls. The only exception will be persons who operate the reactor for educational purposes, when a licensed Operator or Senior Operator is present at the console. Changes in power level will be under the direct supervision of a Senior Operator.
2. Loading or unloading of the fuel elements in the core will be done only under the direct supervision of a Senior Operator, with a minimum of another licensed Operator, and one other person present. This will be enforced by keeping the fuel element handling tools locked in place with the only keys in the possession of the Senior Operator on Duty.
3. In loading any configuration change of more than one element, or following any significant change of ($\Delta\rho \geq 0.2\%$) in nearby experimental equipment or experiments, the reactor will be brought to criticality by means of a critical experiment under the direct supervision of a Senior Operator.
4. No individual experiment worth more than 0.7% in reactivity will be installed in the reactor, no single moveable experiment worth more than 0.4% will be installed in the reactor, and the worth of all moveable experiments shall be no greater than 0.6% reactivity.
5. Following the loading of a core configuration previously logged, the approach to critical will be made under the direction of a Senior Operator but need not be done by means of a critical experiment.
6. The system for designating a loading will be as follows: any change in fuel of a critical mass will be designated by a number. Any change in reflector will be designated by a letter following the number of a particular core loading. Loading diagrams of each core shall be inserted in the proper log book of core loadings, and a core data sheet filled out for each core. A loading will not be designated by a new number or letter unless the reactor is taken

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

7. The reactor will be operated with the minimum amount of excess reactivity necessary to fulfill operational requirements, and those requirements will be at the discretion of the Senior Operator on Duty.
8. Personnel in the Reactor Building will be informed over the public address system about changes made to the reactor status. This includes startups, power changes and shutdowns.
9. All reactor operational personnel are responsible for entering in the appropriate log book any work on or around the reactor or reactor components important enough to justify a record for future reference.
10. All personnel are responsible for notifying the Senior Operator on Duty of any work being done.
11. Radioactive samples or sources will be removed from the core or thermal column only under the direction of a Senior Operator. He will in turn seek Health Physics assistance if he deems it necessary. The bridge monitor may be switched to by pass the alarm system when samples are removed under careful survey, at the discretion of the Senior Operator on Duty.
12. Log books will be kept in the control room safe, except the one currently in use, which may be kept on the console. If the books are removed from the control room, permission must be granted by the Reactor Manager. Any books removed shall be returned as soon as possible.
13. Completed recorder chart paper will be dated and filed in designated areas, and kept on file for at least the minimum required time. Log N charts are to be kept as a permanent record.
14. All changes in Core Mode (T or W) will be noted in the permanent log book, including date and time.
15. The use of any interlock by pass key requires a permanent log entry

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 101	REVISED: 12-30-82	PAGE 3 OF 3

TITLE: General Operational Procedures

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 within ten working days to the Reactor Director for Approval or Revision.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 103 | REVISED: 12-30-82 | PAGE 1 OF 4

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 KGL | APPROVED BY: A. E. 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.

8.0 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.

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 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).
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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 103	REVISED: 12-30-82	PAGE 4 OF 4

TITLE: Reactor Start Up Procedure

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).

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.

*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: KGL KGL	APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 104 | REVISED: 12-30-82 | PAGE 1 OF 6

TITLE : Hourly Log and Operational Data

A. Purpose

To provide for records of all phases 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 INK in the Permanent Log. Hourly Logs will detail specific instrument readings for repetition of experiments or training.

B. Precautions, Limitations and Frequency

1. General
    1. All log entries are to be made in INK with times recorded from the console clock. (Black ink is preferred.)
    2. The operator shall not make entries to logs when the reactor is critical and in "Manual Operation". Obtain another individual to record log readings.
    3. The Senior Operator on Duty is responsible for all operational logs. Request his assistance if in doubt about log entries.
    4. The Senior Operator on Duty will review all log entries following completion of daily operations.
    5. The Senior Operator on Duty will report any abnormal conditions, entered in the operational logs to the Reactor Manager.

C. Procedure

1. Hourly Operating Log Entries
    1. The hourly log sheet will be dated and each operator (student, trainee, etc.) will place their name in appropriate spaces provided.
    2. Another (or new) hourly log sheet will be started only when all available columns have been filled during the current day of operation, (i.e. a new hourly log is not required for each startup checklist SOP 102).

WRITTEN BY: CMB CMB | APPROVED BY: A. E. Bolon

3. The reactor will be at a stable power level with the Reg Rod in "Auto" or 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.)
4. 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 shown on the Linear Recorder in kilowatts or watts.
    4. Linear level recorder reading in percent of present selected scale.
    5. Linear Level Amplifier Selector Switch value in amps.
    6. Reg Rod in "Auto" yes or no.
    7. Log N Recorder reading in kilowatts.
    8. Shim Rod #1 Rod Position Indicator Reading to four places (ie. 24.15).
    9. Same as Step 8 for Shim Rod #2.
    10. Same as Step 8 for Shim Rod #3.
    11. Reg Rod--Rod Position indicator reading to three places (ie. 12.5).
    12. Check Radiation Area Monitors (Reactor Bridge, Demineralzer and Beam Room) for approximately the same values observed during completion of startup checklist (SOP 102).
    13. Check Magnet Currents for approximately the same values observed (and recorded) during completion of the startup checklist (SOP 102).
    14. Reactor Power Level indicated on the #1 Power Range Meters in percent. This meter corresponds to 200 kilowatts at

100%.

15. Same as Step 14 for #2 Power Range Meter.
16. 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).
17. Record the Reactor Bridge Radiation Area Monitor value in millirems per hour.
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
   1. All entries in the permanent log shall be preceeded by the date (use date stamp).
   2. During completion of the Startup Checklist SOP 102 use the check out stamp and complete values as they become available. To the right of this stamp indicate the class or project number. The nature of the experiment should also be shown. See example below:

JUN 10 1981

0831 Started Check Out

1135 Rods at 6 Inches

1423 Reactor at 180.0 kw

NE 306

1/M plot.

Note on previous example that Reactor Power is recorded in kilowatts.

3. Reactor power changes are made in accordance with the SOP 103 and entries are made prior to the start of a power change and at the new stable power level (stable power level entry made during Step 16 of hourly log entries).

   The example below indicates permanent log entries for a power change including shutdown of the reactor.

   10:28 Started to 600W
   10:30 Reactor at 600W
   10:35 Reactor Shutdown

4. 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.

DATE JUN 10 1981 FIRST

SAMPLES, EXPERIMENTS

Facility, Position	Experimenter and Experiment	Start Time This Date	Stop Time This Date	Total Time
C7	(10) NE308, AuFoil	1410	1431	21 min

Note: Number in ( ) indicate the number of samples.

TITLE : Hourly Log and Operational Data

3. Recorder Chart Paper
   1. Date all 5 primary recorders in accordance with SOP 102 (startup checklist) and SOP 105 (shutdown checklist).
   2. 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.
   3. All chart paper is retained for a period of TWO YEARS except for the Log N Chart which is retained for the duration of facility operation.
4. Ventilation Fan Operating Log
   1. After receiving approval from SRO to start or stop a building exhaust ventilation fan, complete the requested information on Fan Operation Log (ie. time, fan#, power level etc.)
   2. Fan Operation Charts are used to calculate gas and particulate Radiation Release from the Facility. These logs are retained in the Facility Health Physics files.

WRITTEN BY: CMB

APPROVED BY: A.E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 104 | REVISED: 12-30-82 | PAGE 6 OF 6

TITLE : Hourly Log and Operational Data

HOURLY LOG

Operators: (1) ____________________ (3) ____________________

(2) ____________________ (4) ____________________

Date ____________________ Senior Operator ____________________

1. Time													
2. Operator's Initial													
3. Nominal Power (W or Kw)													
4. Linear Level Recorder (%)													
5. Linear Level Scale (Amps)													
6. Auto Set													
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. Magnet Currents Normal													
14. Power Chamber No. 1 (%)													
15. Power Chamber No. 2 (%)													
16. Permanent Log Entries													
17. Record Bridge Monitor (mr/hr)													
18. Record Water Temperature (^{o}F)													
19. Project or Class Number													
20. Core Loading Number													

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

WRITTEN BY: CMB C.M.B. | APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 105	REVISED: DEC 30 1982	PAGE 1 OF 4

TITLE : Shutdown Checkout Procedures and Checklist

A. Requirements

The reactor shall be secured prior to the daily closing of the facility if the reactor has been in operation. The nature of the shutdown will be determined by the Senior Operator on Duty depending on the situation and time of shutdown. The shutdown checkout form will be numbered consecutively following the last two digits of the current year.

B. Responsiblity

It will be the responsibility of the operator performing the checkout to make sure that each step is satisfactorily completed. The operator may assign various steps to be completed by other personnel, in which case, the responsibility lies primarily with the person performing that step.

C. Procedure for Shutdown

With the reactor at a stable power level in "Auto" and the reactor is to be shutdown under normal conditions (ie.Operator action). If the reactor is in "Manual" Steps 1 and 2 will be done by the operator assistant and Step 4 is not required.

1. Log the present time (from 24 hour clock) on the hourly logs, followed by your initials and then the word "Shutdown" through the remaining spaces on that portion of the Hourly Log.
2. Log the present time (from 24 hour clock) in the Permanent Log Book followed by the word "Shutdown".
3. Announce over the Building P.A. that, "The reactor will be shutdown".
4. Trip the auto/manual selector switch to the manual position and acknowledge the annunciator alarm for "Manual Operation".
5. Place the operate-shutdown switch to the shutdown position (switch will lock in the position).

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

6. Monitor the decrease in reactor power by changing the Linear NI Selector Switch (1 scale CW) when the Linear Recorder decreases to 30% of the present scale. Operation at high power levels will prevent returning to lowest allowed scale ($3x10^{-11}$ amps) and therefore this step is continued only until rods reach their insert limit values (0.0 inches).
7. Monitor the decrease in reactor power on the Log Count Rate Recorder and maintain the LCR >20 CPS. This will prevent the <2 CPS alarm and avoid a rod withdrawal prohibit.
8. When all rod motion has been automatically terminated by the rods reaching their respective insert limits (green lights), return the operate-shutdown switch to the operate position.
9. The reactor is now shut down. Continuing operation with a restart or securing of the reactor will be at the discretion of the Senior Operator on Duty.

D. Procedure for Securing Reactor

At the completion of full insertion of the rods during the reactor shutdown, the operator will contact the Senior Operator on Duty concerning the nature of the shutdown. If the Senior Operator on Duty designates "securing" the reactor, the operator will go through a shutdown checkout form SOP 105 which will give definite assurance that all systems are properly secure for shutdown conditions. The following procedure steps correspond to the step number of the Shutdown Checklist, (form SOP 105). This list must be completed for "Securing" the reactor.

1. Use date stamp.
2. All Shim Safety and Reg Rod Insert Limit (Green) Lights on.
3. All Shim Safety Magnet Contact (Blue) Lights on.

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 105	REVISED: DEC 30 1982	PAGE 3 OF 4

TITLE: Shutdown Checkout Procedure and Checklist

4. Turn magnet key 90° CCW and remove from console.
5. Hand key to SRO on Duty (your instructor).
6. Turn off the Log Count Rate, Linear, Period, Log N and Temperature Recorder and place date at the top of each recorder chart (use date stamp).
7. Stamp the Log N Chart with the Log N Recorder Stamp and complete all requested information (your initials).
8. Push Annunciator Reset. During normal Shutdown the Manual Scram, Recorders Off and Manual Operation Annunciators will remain on.
9. Push Station #6 (reactor bridge) intercom switch to return all switches to the off position (button up).
10. Turn operation switch on Counter/Scaler to the off position.
11. Change CCTV monitor selector switch to the "Door" position.
12. Turn off the Nitrogen Diffusers and/or Ventilation Fans, unless advised otherwise by the SRO on Duty.
13. Log the time using a 24 hour clock.
14. Your initials.
15. Senior Operator on Duty should initial.

Any malfunctions or abnormal conditions noted during or after the Shutdown will be recorded in the Permanent Log and the SRO on Duty shall be notified. Return Operational Log Book and the Permanent Log Book to their proper storage location. Properly dispose of all trash, coffee cups, soda cans, etc. and leave the Control Room in a clean and orderly appearance.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 105 | REVISED: DEC 30 1982 | PAGE 4 OF 4

TITLE : Shutdown Checkout Procedures and Checklist

UMRR SHUTDOWN CHECKLIST
SOP 105

Number:__________________

1. Date											
2. All Rods on Insert Limit											
3. All Magnet Contact Lights On											
4. Magnet Power Off											
5. Magnet Key to SRO on Duty											
6. Recorders Off											
7. Stamp and Record Data On Log N Recorder Chart											
8. Clear Annunciator											
9. Reactor Bridge Intercom Off											
10. Counter/Scaler Off											
11. CCTV to Door											
12. Nitrogen Diffusers and/or Vent Fans											
13. Time Completed											
14. Operator's Initials											
15. Senior Operator's Initials											

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 208
REVISED: 12-30-82
PAGE 1 OF 3

TITLE: Reactor Security

A. <u>Purpose</u>: to provide the necessary information to student operators and to service as a guide to the operating staff for compliance with the Physical Security Plan of the UMR Reactor. The Physical Security Plan provides protection against radiological sabotage and for detection of theft of Special Nuclear Material. The Physical Security Plan contains information withheld from public disclosure and therefore is not available for review by students or visitors.

B. <u>Precaution, Frequency and Limitations</u>

1. The main entrance to the nuclear reactor building will be locked at all times with electrical access control at the office/reception secretary's desk.
2. Entry or exit to the building from other than the main entrance shall require the continuous presence of a member of the reactor staff and permission of the Reactor Manager or Director. These doors will be used only for freight, packages, trash disposal, etc., and not for personnel access.
3. Individuals granted unescorted access will be given identification badges upon entry to the facility. The ID badge will be worn proximity to the film badge. This ID badge shall not be worn outside the nuclear reactor building. The ID badges are to be returned to the secretary when exiting the facility.
4. Individuals with unescorted access are responsible for insuring that visitors are escorted (audible and visual contact) at all times while inside the facility.
5. Visitors to the facility must sign the Visitors Log and be issued a radiation detection device. They must consent and abide with the visitors rules and regulations posted at several locations around the facility.

WRITTEN BY: KGL

APPROVED BY: A. E. Bolon

6. The visitor-to-escort ratio will not exceed 20-to-1.
7. Vehicles and packages leaving the nuclear reactor facility (with the exception of the office area) are subject to random search by the reactor staff.
8. In the event of a situation occurring which could affect the security of the facility, the reactor will be shutdown and the magnet key secured.
9. The Senior Operator on Duty may lock the bay doors preventing access to the reactor bay area if the situation warrants.
10. The Senior Operator on Duty may find it necessary to seek assistance from law enforcement agencies as follows:

State Highway Patrol	364-1215
UMR Campus Police	341-4300
Rolla City Police	364-1213

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

C. Procedure:

1. Three or less visitor(s) seeking entry to the facility.
    1. If a visitor's identity is unknown he/she shall be allowed access only by direct action of the reactor staff. Access should not be allowed by remote electric control.
    2. Require identification, if the individual states that this is a business call or does not request a general tour of the facility.
    3. Inform the visitor that books, packages, etc., must be left in the office area.
    4. Issue the individual a dosimeter after recording its initial value and serial number in the Visitors Log.
    5. The visitor is to complete the necessary information in the

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 208	REVISED: 12-30-82	PAGE 3 OF 3

TITLE: Reactor Security

Visitor Log including: Name, address, date, time and any information at the discretion of the escort.

    6. Inform the visitor's that they must remain in audible and visual contact with their escort at all times.
    7. Conduct tour or business as necessary.
    8. Prior to exiting the facility retrieve the dosimeter and record the final reading in the Visitors Log. Inform the visitor of the amount of radiation received during the tour or business visit.

2. Four or more visitors seeking entry to the facility.
    1. All steps of SOP 505.3.1 above apply with the exception that dosimeters may be placed in the bay area at suitable locations and the maximum dosimeter radiation value obtained will be credited to all members of the tour during their visit.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 302	REVISED: DEC 30 1982	PAGE 1 OF 2

TITLE: Inspection of Control Rods

A. Reactivity Requirements

Before a control rod can be removed from the core, all fuel elements necessary to insure the loading is below 50% of the critical mass when all rods are removed, shall be removed from the core.

B. Personnel Requirements

For this procedure there must be a Senior Operator on Duty, one Reactor Operator and one assistant with some fuel handling experience in the bay area. Also a health physicist or his representative shall be present.

C. Material Requirements

Control rod removal jumper cable.
Control rod removal safety basket.

D. Procedure

1. Person in charge will contact the Reactor Manager to obtain permission.
2. The startup check out will be completed, and the control rods withdrawn to the 50% mark.
3. Fuel transfer forms (SOP 106) will be filled out and checked for accuracy.
4. Fuel will be transferred one element at a time as directed by person in charge until all required elements have been removed in accordance with SOP 207. If the fuel has been previously unloaded (eg. the day before) it is not necessary to repeat the startup check out procedure; however, it would be proper to have the recorders on.
5. The control rods will be fully inserted into the core and magnet power de-energized.
6. The scram magnet extension and control rod drive shroud will be removed and suspended from bridge. One of the extensions must be completely removed from the shroud.
7. Connect the control rod removal jumper cable to the magnet extension and the normal magnet connector.

WRITTEN BY: Mike Middleton	APPROVED BY: A.E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 302	REVISED: DEC 3 0 1982	PAGE 2 OF 2

TITLE: Inspection of Control Rods

8. Place the rod removal safety basket as close to the rod to be removed as possible.

9. The scram magnet will manually be placed on the rod to be removed and magnet power energized to normal current plus 20 ma.

10. The Senior Operator on the bridge will carefully supervise or perform the withdrawal of the control rod element and place it in the safety basket. Note: care must be taken to keep the extension and rod vertical to prevent dropping the rod.

11. De-energize magnet power and disconnect the extension. Carefully raise the rod in the basket.

12. When the control rod is out of the pool, place the control rod behind as much shielding as necessary, and inspect for pitting and cracking. Record general comments and any particular information for each rod.

13. Using basket, lower rod into the pool, and position near control rod elements. Position magnet over the rod, energize magnet power and withdraw the control rod from the basket. Place rod into control rod element and de-energize magnet power.

14. Repeat steps 8 through 14 for the other 2 control rods.

15. Reinstall magnet extensions and control rod drive shrouds. Withdraw rods to 50% mark and reload core as normal.

16. Log results of inspection in reactor log.

17. Log results of inspection on most recent Reactor Semi-Annual Check List.

18. Have Manager and/or Director review the results and initial.

WRITTEN BY: Mike Middleton	APPROVED BY: A.E. Bolon AEB

and the sweep start when the auxillary switch is depressed energize magnet power and raise Rod 1 to 6" and depress the auxillary scram switch. The Drop Time will be the time from the start of the sweep on the scope to the big blip on the scope.

J. Repeat Step I for Rods 2 & 3 and record all data in the permanent log.

K. Repeat Steps I and J for 12", 18", and 24".

L. Next measure the separation time by adjusting the oscilloscope to have a very fast sweep time and be certain to adjust the "Trig Level Stability" knob so that the external trigger works properly. Then repeat Step I at 6" for all the rods using the minimum magnet current and the maximum current as defined below. (Note. A polaroid photograph of the oscilloscope trace will be helpful. The distinction between the initial noise signal and the separation signal is not too definite.)

Definitions:

1. Minimum magnet current is the drop current plus 5 ma.
2. Normal magnet current is the drop current plus 10 ma.
3. Maximum magnet current is normal current plus 10 ma.

4. The separation time will be calculated as the average of the average separation time for the maximum current and the average separation time for the minimum current. (Thus, it will represent a typical separation time for a normal current.)

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 307	REVISED: 12-20-82	PAGE 3 OF 3

TITLE: Rod Drop Times

M. List all data in last Semi-Annual and Core Data Sheet.

N. Shutdown reactor and remove all rod drop equipment.

O. Reconnect jumper between TB5-31,32.

P. All rod drop times must be <600 msec and separation times must be <50 msec.

WRITTEN BY: Carl M. Barton	APPROVED BY: A.E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 501	REVISED: 12-30-82	PAGE 1 OF 7

TITLE: Emergency Procedures for Reactor Building Evacuation

A. Introduction

In case of any abnormal situation arising in the Reactor Building, which may be hazardous to life or property, a personnel evacuation procedure will be followed. This Emergency Procedure is prepared to meet any eventuality such as a radiation hazard, a reactor incident, or other hazardous situations all of which are highly improbable.

This Procedure is to be put into operation immediately after an accident or incident in or around the Reactor Facility. Examples of such an emergency condition are the following:

1. Spill of radioactive material.
2. Insufficient shielding of an experiment utilizing the reactor.
3. Rupture of a sample container which may constitute an air contamination hazard.
4. Fire or chemical explosion.
5. Reactor malfunction.

B. Initiation of a Building Evacuation

Radiation Monitor Alarm Systems

The reactor laboratory is equipped with a horn which serves as building evacuation alarm. It is connected to the radiation monitor on the reactor bridge and will sound automatically whenever a gamma radiation level of 20 mr/hr is exceeded.

A secondary radiation monitoring system is installed in the Reactor Facility to supplement the primary system. This monitoring system gives the Reactor Operator additional information on potential radiation hazards in the building. The system is adjusted so that a radiation level of 10 mr/hr or greater in the monitored area will sound a buzzer and turn on red lights at the monitor unit and on the annunciation panel at the reactor control center. These units are located at the beam-port level at the demineralizer level and on the reactor bridge. Provisions have also been made so that additional monitoring units can be installed in other experimental areas at any time.

The Reactor Operator, upon receiving an indication on his annunciator panel of a high-radiation level in any one of the monitored areas will initiate the following actions:

1. The Reactor Operator will announce immediately on the building public address system that an alarm has been received.
2. The Senior Operator will proceed immediately to the reported area and ascertain the existence of a hazard.

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

3. He will then report to the Reactor Operator, via the intercom system, as to the nature of the trouble.
4. If the situation is in any way a personnel hazard, the Reactor Operator, must actuate the building evacuation alarm, scram the reactor, and evacuate the building.
5. Reactor personnel, experimenters, and any other persons in the vicinity of a radiation monitor sounding an alarm must immediately follow the established evacuation procedure.

C. <u>Responsibilities</u>

The primary responsibility for determining a building emergency rests with the Senior Operator on Duty at the time of the emergency. However, if emergency conditions do arise and the Senior Operator is not available, the Reactor Operator, Health Physicist, or individual experimenter must determine whether a building evacuation should be implemented. After the building evacuation alarm system is actuated, the following action must be taken:

1. The Senior Operator on Duty shall
   a. see that the building is evacuated.
   b. ascertain that the emergency is real.
   c. pick up the Senior Operator's Emergency Checklist (see Table SOP 501) and portable monitoring equipment.
   d. evacuate the building himself.
   e. in case of a fire, call the Fire Department.
   f. obtain additional portable monitoring instruments at the Physics Building.
   g. contact the Campus Health Physicist and report the emergency.
   h. contact the Reactor Director and report the emergency.
   i. take any remedial action that he deems necessary.
2. The Reactor Operator shall
   a. scram the reactor
   b. remove the magnet power key
   c. obtain radiation instruments
   d. turn off the exhaust fans
   e. obtain the keys to the Physics Building where emergency equipment is kept.
   f. evacuate the building himself.
3. The Health Physicist shall
   a. upon notification, go to the site and determine immediately the extent of the radiation and contamination hazard.

  b. supervise the decontamination, if any, of the personnel, equipment, and laboratory.
  c. insure that all personnel involved in any cleanup operation are properly clothed and protected for the operation.
  d. direct and assist in the arrangement of emergency shielding, if necessary.
  e. call upon any of the reactor staff or other University personnel, including the Campus Police, to assist in correcting the abnormal conditions.

D. <u>Evacuation</u>

Upon hearing the emergency building evacuation alarm signal, all reactor staff, laboratory personnel, and any other persons, shall leave the Reactor Building immediately. Fans and ventilating equipment should be turned off by the Reactor Operator or by evacuating personnel.

Personnel will be evacuated to the basement of the Physics Building for shelter and decontamination (if needed). Telephones in this building will be available for calls for assistance.

E. <u>Survey Instruments</u>

Survey instruments are kept on a rack by the control room door.

Additional instruments are stored in the Physics Building for emergency use.

F. <u>Protective Devices</u>

Suitable respirators and spare filter packs are kept sealed in plastic bags in the Health Physics office. Emergency respirators are stored in the Physics Building.

Special coveralls, shoe covers, and gloves for emergency cleanup are stored in the basement of the Physics Building.

G. <u>Procedure for Notifying School Personnel and Surrounding Communities of an Impending Radiation Hazard.</u>

It is always possible, although highly improbable, that a portion of the reactor fuel could have failed. In such an occurrence, fission product gases could be released from the building. Dispersion of the fission product cloud in the atmosphere is dependent on weather conditions at the time of the accident.

If such a situation occurs, it is the responsibility of the Health

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

   Vacant

2. Reactor Director, Albert E. Bolon

Campus Telephone	341-4236
Home Telephone	364-1961
Home Address	Rt. 3, Box 213A, Rolla, Mo. 65401

3. Health Physicist, Ray Bono

Campus Telephone	341-4240
Home Telephone	364-5728
Home Address	Box 573, Rt.2, Rolla, Mo. 65401

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 501 | REVISED: 12-30-82 | PAGE 5 OF 7

TITLE: Emergency Procedures for Reactor Building Evacuation

4. Radiation Safety Officer, Nicholas Tsoulfanidis

Campus Telephone	341-4721
Home Telephone	341-3595
Home Address	Rt.4, Box 86, 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

WRITTEN BY: KGL KGL

APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 501	REVISED: 12-30-82	PAGE 6 OF 7

TITLE: Emergency Procedures for Reactor Building Evacuation

SRO EMERGENCY CHECKLIST	Action Completed Time
1. Alarm Sounded	
2. Reactor Shutdown	
3. Exhaust fans turned off	
4. Building evacuated #of people to door of Physics Bldg.	
5. Radiation Instruments obtained	
6. Keys to emergency storeroom checked and tested.	
7. Type of Emergency Type__________ SRO __________	
8. Fire	
A. Notify Fire Department Ph: 9 364-1230	
B. Contact Health Physicist Ph: 341-4240	
C. Notify Reactor Director Office: 341-4720 Home : 364-6583	
D. Notify Business Office Ph: 341-4121	
E. Notify Campus Police Ph: 341-4300	
F. Stand-By with Protective Devices 1. Respirators 2. Coveralls 3. Shoe cover 4. Gloves	
G. End of Emergency SRO__________	
9. Radiation Emergency	
A. Notify Health Physicist Ph: 341-4240	
B. Notify Business Office Ph: 341-4121	
C. Set up control point	
D. Check for Contamination # of contaminated personnel	
E. Call campus police	

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 501 | REVISED: 12-30-82 | PAGE 7 OF 7

TITLE: Emergency Procedures for Reactor Building Evacuation

SRO EMERGENCY CHECKLIST, CONTINUED

	Action Completed Time
F. Check for injured Personnel#	
G. Call hospital and ambulence if needed Ph: hospital 354-3100	
H. Start Decontamination	
I. End Emergency SRO_________	

WRITTEN BY: KGL

APPROVED BY: W. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 502	REVISED: 12-30-82	PAGE 1 OF 2

TITLE: Emergency Procedures for a Notification of Unusual Events

A. Emergency Action Levels
The Emergency Director (Reactor Director) shall determine if a Notification of Unusual Events condition exists and will respond to the emergency by implementing the appropriate procedures. A Notification of Unusual Events condition would exist if one of the conditions listed in the Action Levels in Table I of the UMR Reactor Emergency Plan existed. (See the attached.) Notification of Unusual Events conditions are not expected to warrant emergency notification of offsite organizations.

B. Assessment Actions
Containment building and site boundary airborne radioactivity levels shall be determined from the area radiation monitors and portable monitoring equipment by members of the emergency organization. The Emergency Director shall use this information and Table I to determine that the emergency is appropriately classified.

C. Corrective Actions
The reactor shall be shut down. Physical barriers to contain the radioactivity shall be maintained or implemented where necessary. Installed cleanup systems may be used to reduce the release of radioactive material. Further corrective actions shall be provided as needed for this emergency class.

D. Protective Actions
The Protective Actions for this emergency classification are based upon a Guide of 1 rem whole body and 5 rem thyroid to members of the general public onsite and UMRR Staff. Accountability of personnel following a building evacuation shall be done by the Senior Operator on Duty who will check that the facility is clear of personnel. Further protective actions shall be provided as needed for this emergency class.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 502	REVISED: 12-30-82	PAGE 2 OF 2

TITLE: Emergency Procedures for a Notification of Unusual Events

SOP 502 Table I(1)

Emergency Class: Notification of Unusual Events

Action Levels	Purpose
1) Actual or projected radiological effluents at the site boundary exceeding 10 MPC* when averaged over 25 hours or 15 mrem whole body accumulated in 24 hours.	a) to assure that the first step in any response later found to be necessary has been carried out,
2) Report or observation of severe natural phenomenon.	b) to bring the operating staff to a state of readiness, and
3) Receipt of bomb threat.	c) to provide for systematic handling of unusual events information and decision making.

*MPC = maximum permissible concentration.

---

1. (Reference: UMR Reactor Emergency Plan, Table I.)

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 503	REVISED: 12-30-82	PAGE 1 OF 2

TITLE: Emergency Procedures for an Alert

A. Emergency Action Levels
The Emergency Director shall determine if an Alert condition exists and will respond to the emergency by implementing the appropriate procedures. An Alert condition would exist if one of the conditions listed in the Action Levels in Table I of the UMR Reactor Emergency Plan existed.* Alert conditions may require providing emergency notification and status information to offsite organizations.

B. Assessment Actions
Containment building and site boundary airborne radioactivity and radiation levels shall be determined from area radiation monitors and portable monitoring equipment by members of the emergency organization. The Emergency Director shall use this information and Table I to determine that the emergency is appropriately classified.

C. Corrective Actions
The reactor shall be shut down. Physical barriers to contain the radioactive material shall be maintained or implemented where necessary. Installed cleanup systems maybe used to reduce the release of radioactive material. Further corrective actions shall be provided as needed for this emergency class.

D. Protective Actions
The Protective Actions for this emergency classification are based upon a Guide of <u>1 rem whole body and 5 rem thyroid</u> to members of the general public onsite. Accountability of personnel following a building evacuation shall be done by the Senior Operator on Duty who will check that the facility is clear of personnel. Further protective actions shall be provided as needed for this emergency class.

---

*See the attached.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 503 | REVISED: 12-30-82 | PAGE 2 OF 2

TITLE: Emergency Procedures for an Alert

SOP 503 Table I(1)

Emergency Class: Alert

Action Levels	Purpose
1) Actual or projected radiological effluents at the site boundary exceeding 50 MPC* when averaged over 24 hours or 75 mrem whole body accumulated in 24 hours.	a) to assure that emergency personnel are readily available to respond if situation becomes more serious or to perform confirmatory radiation monitoring if required, and,
2) Actual or projected radiation levels at the site boundary of 20 mrem/hr for 1 hour whole body or 100 mrem thyroid dose.	b) to provide offsite authorities with current status information.

*MPC = maximum permissible concentration.

---

1. (Reference: UMR Reactor Emergency Plan, Table I.)

WRITTEN BY: KGL | APPROVED BY: A.E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 504	REVISED: 12-30-82	PAGE 1 OF 2

TITLE: Emergency Procedures for a Site Area Emergency

A. Emergency Action Levels

The Emergency Director shall determine if a Site Area Emergency condition exists and will respond to the emergency by implementing the appropriate procedures. A Site Area Emergency would exist if one of the conditions listed in the Action Levels in Table I of the UMR Reactor Emergency Plan existed. (See the attached)

Site Area Emergency conditions may require evacuation of non-essential personnel to beyond the site boundary, and require providing emergency notification and status information to offsite organizations and the public.

B. Assessment Actions

Containment building and site boundary airborne radioactivity and radiation levels shall be determined from area radiation monitors and portable monitoring equipment by members of the emergency organization. The Emergency Director shall use this information and Table I to determine that the emergency is appropriately classified. The Campus Health Physicist will determine release and contamination magnitudes and to estimate projected exposures to onsite and offsite population.

C. Corrective Actions

The reactor shall be shut down. Physical barriers to contain the radioactive material shall be maintained or implemented where necessary. Installed cleanup systems maybe used to reduce the release of radioactive material. Further corrective actions shall be provided as needed for this emergency class.

D. Protective Actions

The Protective Actions for this emergency classification are based upon a Guide of 1 rem whole body and 5 rem thyroid to members of the general public onsite and UMRR staff. Accountability of personnel following a building evacuation shall be done by the Senior Operator on Duty who will check that the facility is clear of personnel. Further protective actions shall be provided as needed for this emergency class.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 504	REVISED: 12-30-82	PAGE 2 OF 2

TITLE: Emergency Procedures for a Site Area Emergency

SOP 504 Table I(1)

Emergency Class: Site Area Emergency

Action Levels

1) Actual or projected radiological effluents at site boundary exceeding 250 MPC* when averaged over 24 hours or 375 mrem whole body accumulated in 24 hours.

2) Actual or projected radiation levels at the site boundary of 100 mrem/hr for 1 hour whole body or 500 mrem thyroid dose.

Purpose

a) to assure that response centers are manned,

b) to assure that monitoring teams are dispatched,

c) to assure that personnel required for evacuation of onsite areas are at duty stations,

d) to provide consultation with offsite authorities, and

e) to provide information for the public through offsite authorities.

*MPC = maximum permissible concentration.

---

1. (Reference: UMR Reactor Emergency Plan, Table I.)

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 505 | REVISED: 12-30-82 | PAGE 1 OF 1

TITLE: Emergency Procedures for Enhanced Reactor Security

A. In the event of any disorder on the campus of the University of Missouri-Rolla which could for any reason have an effect on the security of the Nuclear Reactor Facility the following Emergency Procedures will be observed.

1. In the event of a situation occurring which could affect the security of the Facility the reactor will be immediately scrammed and the magnet power key secured in its normal storage location.
2. All entrances to the building shall be locked 24 hours per day.
3. Access to the main entrance will be controlled by an electric lock with opening stations either on the secretary's desk in the lobby or in the control room.
4. Only persons who can be identified and have a need to be in the building will be admitted.
5. The Senior Operator on Duty will lock the inside doors which are entrances to the reactor bay and the control room. Thus to gain entrance to the vital areas of the building both the main entrance door and an inside door would have to be opened.
6. The Senior Operator on Duty would call the Highway Patrol, the city police and the campus police, in that order. The Fire Department would also be called if deemed necessary.
7. The reactor staff shall not enter into any confrontation with any persons, except to provide for their personal safety.

WRITTEN BY: CMB | APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 506 | REVISED: 12-30-82 | PAGE 1 OF 1

TITLE: Emergency Procedures for a Bomb Threat

A. A telephone call involving a bomb threat will be handled in accordance with normal campus procedures.

B. The person taking the call will attempt to obtain as much of the information on the Campus Bomb Threat Form as possible.

C. If the reactor is in operation at the time of the call, the person receiving the call should let the Senior Operator on Duty know about the call and the Operator should

   a. scram the reactor,
   b. secure the magnetic power key in its usual storage place, and
   c. initiate a building evacuation in accordance with SOP501.

D. If the reactor is not in operation at the time of the call, the person receiving the call should notify the Reactor Manager or Senior Operator if the Reactor Manager is not there. The Reactor Manager (or his representative) shall initiate a building evacuation in accordance with SOP 501.

E. The incident should be reported immediately to the University (campus) Police by the person who received the call via a telephone in the Physics Building.

F. The Reactor Staff should not attempt to find an alleged bomb. The Senior Operator on Duty should be on the lookout for unusual packages as he checks that everyone has evacuated the building.

G. The University Police will assume the responsibility for the emergency from this point on.

H. The Reactor Director and the Chief of University Police shall decide when the emergency no longer exists.

WRITTEN BY: CMB

APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 701 | REVISED: DEC 20 1982 | PAGE 2 OF 6

TITLE: Request for Reactor Projects

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 an annual report or other publication. 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. The second item to be covered in the project description is the hazards or safety analysis. The detail required in this analysis depends markedly on the project.

13. Section 6.0 (experiments) of Appendix A; Technical Specifications to License number R-79, issued to the University of Missouri - Rolla Board of Curators limits the type of materials 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 $1x10^{16}$ neutrons. All projects shall be reviewed for compliance with the Technical Specification by the Reactor Staff.

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

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 810	REVISED: 12-30-82	PAGE 1 OF 14

TITLE: Weekly Check

A. Purpose

To insure the proper operation of the annunciator, control and safety related instruments setpoints. The setpoints will be checked to insure their operation is within the operation limits of the Technical Specifications or Standard Operating Procedures.

B. Frequency, Precautions, Prerequisites.

1.0 The Weekly Check will be completed on the first working day but no later than the third working day of each week when the reactor is operable. Operable status will be determined by the Reactor Engineer.

2.0 Checklist Form SOP 811 will be used during the Weekly Check SOP 810 for documentation and records.

3.0 This check will be done only by a Licensed Operator, Senior Reactor Operator or a student under the direct supervision of a Senior Reactor Operator.

C. Procedure

1.0 Inform the SRO on duty, obtain a blank copy of Form SOP 811 and Date the copy.

2.0 Select the Reactor Bridge Station on the Building Intercom, check the PA system, Install the neutron source, Turn on all 5 primary recorders (date the recorders), Turn on core camera and select core on the monitor selector.

3.0 Obtain Magnet Power Key and turn on magnet power.

4.0 Rod Prohibit (yellow lights)

a. Recorders off ... the rods will not withdraw if anyone of 5 primary recorders is turned off.

1. Turn off LCR recorder.
2. Attempt to withdraw rods.
3. Turn on LCR recorder, reset alarm.
4. Turn off linear level recorder.

WRITTEN BY: DRC DRC

APPROVED BY: A. E. Bolon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 810	REVISED: 12-30-82	PAGE 2 OF 14

TITLE : Weekly Check

5. Attempt to withdraw rods.
6. Turn on linear level recorder, reset alarm.
7. Turn off period recorder.
8. Attempt to withdraw rods.
9. Turn on period recorder, reset alarm.
10. Turn off log N recorder.
11. Attempt to withdraw rods.
12. Turn on Log N recorder, reset alarm.
13. Turn off temperature recorder.
14. Attempt to withdraw rods.
15. Turn on temperature recorder, reset alarm.

b. Log Count Rate <2 CPS

1. Remove source from holder and/or withdraw fission chamber until LCR reads <2 CPS. Record value at which alarm occurs from recorder.
2. Attempt to withdraw rods.
3. Insert source and/or insert the fission chamber to the insert limit. Reset annunciator.

c. Period <30 Seconds

1.0 Depress "Test Trip" switch on Log N & Period Amplifier and adjust for a period <30 seconds. Record value at which alarm occurs on the recorder.

2.0 Attempt to withdraw rods.

3.0 Release test switch, reset alarm.

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

d. Inlet Temperature Above 135°

With recorder on, remove back cover and manually rotate potentiometer arm until alarm occurs, record trip point.

2. Acknowledge alarm and attempt to withdraw rods.
3. Reset alarm on temp. recorder, reset alarm on console.

e. Shim Rods Below Shim Range

1. With all Shim/Safeties below shim range attempt to withdraw the regulating rod. Note that the regulating rod will withdraw just far enough to clear the insert limit light. Attempt to withdraw the Shim/Safety rods. Note that further withdrawal cannot be made. Insert all control blades to the insert limit and record these results.

5.0 Rundown (blue lights)

a. High Radiation Area Monitoring (RAM) System

1. Withdraw rods to 3 inches.
2. Announce "The Building Alarm will sound, this is a test do not evacuate the building", on the Building PA System.
3. Using ram check source switch #1. Note the value at which alarm(s) occurs. Check the automatic reset of the RAM, reset the Building Alarm, (Scram Reset Button), Acknowledge annunciator Rundown Reset and Annunciator Reset. Record value of alarms.
4. Repeat steps 3 for Check Source Switch #2 and #3.
5. All alarms values shall be $\leq$ 30 mr/hr.
6. Upon completion of testing announce "Test Complete, Acknowledge further alarms," on the building PA system.

b. 120% Demand

1. Withdraw rods to 3 inches.
2. De-energize(Linear, Period or LogN) recorder. (Switch to off).
3. Remove potentiometer cover and manually rotate potentiometer arm, note recorder reading when trip point is reached.

4. When inward motion of rods is verified, lower recorder below reset point, reset the rundown and all alarms, turn recorder on and replace cover. Compare actual and specified trip pts.
5. Record trip point value.

c. Period <15 Seconds

1. Repeat steps 1 thru 4 of 5.0 B for the period recorder.

d. 120% Full Power

1. Repeat steps 1 thru 4 of 5.0 B for the Log N Recorder.

e. Low CIC Voltage (Linear)

1. Withdraw rods to 3 inches.
2. Adjust linear scale to 200 Kw ($10X10^{-5}$).
3. Push and hold alarm test button on Linear CIC Power Supply. Observe High Voltage meter and record the value when the under voltage alarm light comes on. Release the test button.
4. Acknowledge the annunciator alarm and observe Low CIC voltage annunciator light. Check for insertion of control rods (rundown in progess).
5. When the High Voltage on the Linear CIC Power Supply has increased to approximately 500 volts push alarm reset. The under voltage alarm light will go off allowing the operator to reset the rundown (push rundown reset) and reset the annunciator.
6. Record Value of the Trip Point.

f. Low CIC Voltage - (Log N)

1. Withdraw the rods to 3 inches.
2. Push and hold alarm test button on the Log N CIC power supply. Observe the high voltage meter and record the value when the under voltage alarm light comes on. Release the test button.

3. Acknowledge the annunciator alarm and observe the Low CIC Voltage annunciator light (also check for $\leq$ 5 sec. period, $\leq$ 15 sec. period, $\leq$30 sec. period, and 150% full power). Reset the period trip light on the Log N & Period Amplifier. This allows for reset of all annunciator lights exdept Low CIC voltage.
4. When the High voltage on the Log N CIC power supply has increased to approximately 500V, push alarm reset. The under voltage alarm light will go off allowing the operator to reset the rundown (push rundown reset) and reset the annunciator.
5. Record Value of trip point.

g. Regulating Rod on Insert Limit on Auto

1. Withdraw the Shim/Safety rods to 3 inches and Reg Rod to 0.5 inches (use the shim range bypass).
2. Select the $3X10^{-11}$ scale on the Linear Amplifier (adjust Compensation voltage to provide a reading of 0.5 to 1.0).
3. Adjust Linear recorder setpoint so that "auto permit" comes on.
4. With regulating rod at approximately 0.5 inches withdrawn, switch the Reg Rod control to "Auto" and reset the annunciator.
5. Adjust the red pointer (auto setpoint) to be slightly below black pointer (Linear signal) so that an insert on the Reg Rod will result.
6. When the Reg Rod reaches insert limit observe Manual Operation and "Reg Rod insert limit on Auto" annunciators.
7. Acknowledge and reset rundown and annunciators.
8. Record results.

h. Bridge Motion Scram (Red lights for Section H thru L)
   1. Withdraw rods to 3 inches.
   2. Release bridge lock and move the bridge a small distance.
   3. Observe a Bridge Motion, Manual Scram and all Magnet contact lights off. Acknowledge the annunciator alarm.
   4. Return bridge to original position and reset all annunciators. Re-insert the Magnets.
   5. Record Results.

i. Period <5 Seconds
   1. Withdraw rods to 3 inches.
   2. Push in and turn trip switch on the Period Section of the Log N Amplifier.
   3. Observe Period Meter for, ≤30 second and ≤15 second annunciators. Continue with trip test button operation until the period light is illuminated on the Log N Amplifier. Record the meter value when this occurs.
   4. Acknowledge annunciator alarm and observe period< 5 second scram, 150% Full Power Scram and Loss of Magnet Contact Lights. Reset the period trip test light on the Log N Amplifier and push reset buttons for the rundown. Insert the magnets and reset annunciators.
   5. Record Value

j. Log N & Period Non-Operative Scram
   1. Withdraw rods to 3 inches.
   2. Turn Log N test from the operate to high <u>or</u> low position.
   3. Observe Log N % Period Amp Non-Operative Scram, Manual Scram, and Magnet contact lights out. Acknowledge annunciators. Reset Manual Scram and reset annunciator. Insert the magnets.

   4. Record results.

k. 150% Full Power Scram

1. Withdraw rods to 3 inches.
2. Push Scram test button on Safety Amplifier. Hold button until both power range meters read full scale and 4 red test lights are on.
3. Push reset on the Safety Amp., Acknowledge the annunciator and observe the 150% Full Power Scram and Magnet Contact lights are off.
4. Reset annunciator and insert the magnets.
5. Record results.

l. Manual Scram

1. Withdraw rods to 3 inches.
2. Push Manual Scram button.
3. Acknowledge the annunciator, observe Manual Scram light and all magnet contact lights are off. Push Scram Reset, Annunciator Reset and Insert the magnets.
4. Record results.

m. Rod Drop Currents

1. Withdraw rods to 3 inches.
2. Set Magnet Current Selector Switch to Magnet 1.
3. Using a screwdriver slowly reduce magnet current using current adjustment #1, until the #1 magnet contact light goes out (you should also hear an audible "click" from the Reactor Bridge Intercom Station). Record this drop current value.
4. Repeat Step 1 thru 3 for Shim Rod 2 and Shim Rod 3.
5. Insert all Shim Rod's to insert limit.
6. Set all Magnet Currents to "normal" (ie Drop Current plus 10 mamps).

n. Test of Annunciators

1. Beam Room High Neutron Flux
    1. Lower alarm set point by turning red needle on log rate

meter to the left. Alarm occurs when black needle is hard against the red needle.

    2. Check for local red alarm light and for white annunciator light on control panel. Return red needle to normal (10K) set point and reset alarm and annunciator.
    3. Record results.

2. Interlock Bypassed
    1. Bypass each interlock one at time to insure that each individual bypass operates the annunciator light.
3. Servo Limits
    1. Note linear level recorder reading.
    2. Change the automatic set point for auto permit by adjusting the star wheel. Note linear level at which light comes on (<+2%). Continue to lower and note reading until the auto permit light goes off (>-2%).
    3. Reset automatic set point to the 100% level.
    4. Record results.
4. Pool Demineralizer Effluent Conductivity High
    1. Have an individual station him (her) self at the conductivity monitor and select the Intermediate level station on the building intercom.
    2. Have the individual select "Meas B" (Demineralizer Effluent) and then reduce the setpoint value until the red (low) alarm light comes on. At this time the annunciator should also alarm.
    3. The Control Room Operator should then inform the individual stationed at the demineralizer to return the setpoint to the 0.5 Meg-ohm value (green light "on").
    4. With this step, complete return building intercom to normal status, reset the annunciator.

TITLE : Weekly Check

5. Record results.

5. Reactor On Lights
   1. With Magnet key inserted and all scrams reset, check the reactor on lights (1) Above Console (2) at reactor entrance and (3) Basement level.
6. Building Evacuation Alarm
   1. Announce over the PA. "The Building Alarm will Sound this is a test, do not evacuate the building".
   2. Push the Building Evacuation Alarm (center of reactor console) and note the audible alarm.
   3. Reset Building Evacuation Alarm by pushing Scram Reset.
   4. Announce over the building PA "Test Complete, Acknowledge all further alarms.".
7. Nitrogen Diffusers
   1. With the bridge intercom station selected, start diffuser #1. The green operation light should illuminate. Note the sound level of the pump and no unusual noise.
   2. Shutdown the #1 pump and repeat step 1 for the #2 nitrogen diffuser.
   3. Record results on form Sop 811.
8. Beam Port and Thermal Column Warning Lights
   1. Announce the building PA. "Attention personnel, stand clear of the Beam Port".
   2. Open the Beam Port by holding the beam port control switch in the open position until the "Red" (open) light comes on.
   3. Acknowledge the annunciator alarm and check the Basement Level Warning Light (Flashing Red).

    4. Close the Beam Port by holding the Beam Port Switch until the Green (closed) Light comes on. Reset the annunciator and observe that the warning light goes out.
    5. Announce over the Building PA "Beam Port Secured". Complete SOP 811.
    6. Dispatch an individual (Licensed RO or SRO) to the Thermal Column with the Thermal Column Key. Select the Basement Level Station on the Building Intercom.
    7. Address the operator over the intercom to open the Thermal Column until the warning light comes on. (approximately 1 inch)
    8. The Control Room Operator should observe and acknowledge the annunciator alarm. Inform the Thermal Column Operator to shut the Thermal Column and insure the warning light goes off.
    9. Reset the annunciator and have the Thermal Column Operator return the key to the key locker. Complete form SOP 811.

9. Ventilation Louvers
    1. Select the Reactor Bridge on the Building Intercom, and start <u>all</u> (3) Building exhaust fans (do not log fan operation), and dispatch an operator with stop watch to the reactor bay.
    2. With the Reactor Bay Operator directly under the #1 Exhaust Fan, the Control Room Operator will shutdown #1 fan when requested to do so over the Reactor Bridge Intercom by the Bay Operator ("Shutdown #1").
    3. The Bay Operator will time the closure of the #1

Exhaust Fan Louvers from the completion of his request to the point of complete closure of the louvers. (No light through louvers). Bay operator will then report closure time to control room operator.

4. Repeat steps 2 and 3 for the #2 and #3 exhaust fans. All closure times will be ≤15 seconds.
5. Complete form SOP 811.

10. Shutdown Check
    1. Complete a Shutdown Check List form 103 to insure that all console equipment is secured.

11. Security System

    Those portions of the fire and security system that are not examined on a daily basis are to be checked for proper operation.

    1. Fire
        1. Contact the Campus Police and inform them that the Fire Alarm System will be checked at the reactor facility.
        2. Using the Fire System master key open a manual pull station. (alternate SOP 811 between office and Intermediate level alarms). Note on SOP 811 the alarm being tested at this time.
        3. Acknowledge at the Fire System control panel; reset the alarm. Reset the pull station and request acknowledgement from Campus Police.
        4. Open the 120V AC Power Supply Breaker #32 on Distribution Panel A.
        5. Repeat steps 2,3 and 4 for Fire Alarm System operating on 24V DC back up power.

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

        6. Close the 120V AC Power Supply Breaker #32 and insure that the Fire Alarm System is back on 120V AC and operating properly.

2. High Radiation
    1. Contact the Campus Police (via telephone) and request that they monitor their High Radiation Alarm. Maintain contact with the Campus Police.
    2. Push the Channel #1, #2 or #3 check source switches until a High Radiation Alarm occurs. Indicate the channel being used to initiate the alarm on SOP 811.
    3. Request acknowledgement of the alarm from the Campus Police on their monitor.
    4. Reset annunciator for the High Radiation Alarm and complete SOP 811.

3. Security (requires two individuals)
    1. Security Door
        1. Inform the campus police that the security system will be checked to insure that all detectors are operating properly.
        2. Hold in or close dead bolt on security door.
        3. Have campus police reset the alarm.
        4. Open dead bolt switch by releasing or opening dead bolt and insure alarm occurs in campus police dispatch station. Have police remain on line for the security checks.

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 810 | REVISED: 12-30-82 | PAGE 13 OF 14

TITLE: Weekly Check

2. Ultrasonic's
    1. Have the campus police reset the ultrasonic alarm section of the security system.
    2. Trip (by slowly walking towards) one of the UT's as shown on figures 3A or 3B of the UMR security plan. Have the campus police notify the reactor when the ultrasonic alarm occurs.
    3. Allow the ultrasonic to reset by moving clear of the detector and then have the campus police reset their alarm.
    4. Repeat steps 2 and 3 for the other ultrasonic detector's as shown on figures 3A or 3B.
3. Duress
    1. Inform the campus police that the duress alarm will be tested.
    2. Monetarily depress the alarm button. The campus police should indicate the satisfactory operation of this alarm.
4. Door's
    1. Reset the door alarm circuit at the reactor then have the campus police reset their alarm.
    2. Open any one of the doors equipped with intrusion alarm as shown on figure 3A or 3B of the UMR Security Plan.
    3. Have the campus police make note of the alarm when the door is opened.
    4. Repeat steps 1,2,3 for each door as shown on figure 3A and 3B. If the door is equipped with more than one detector, both must be checked for proper operation.

WRITTEN BY: DRC | APPROVED BY: A E Bolon

5. When all doors equipped with intrusion alarms have tested, inform the campus police that this completed the weekly security system check at the UMR- Reactor Facility.

5. When all channels of the security system have been functionally tested and operate properly initial the weekly checklist, Form SOP 811.

12. Inform the Reactor Manager of any abnormal or out of service equipment noted during the Weekly Check.