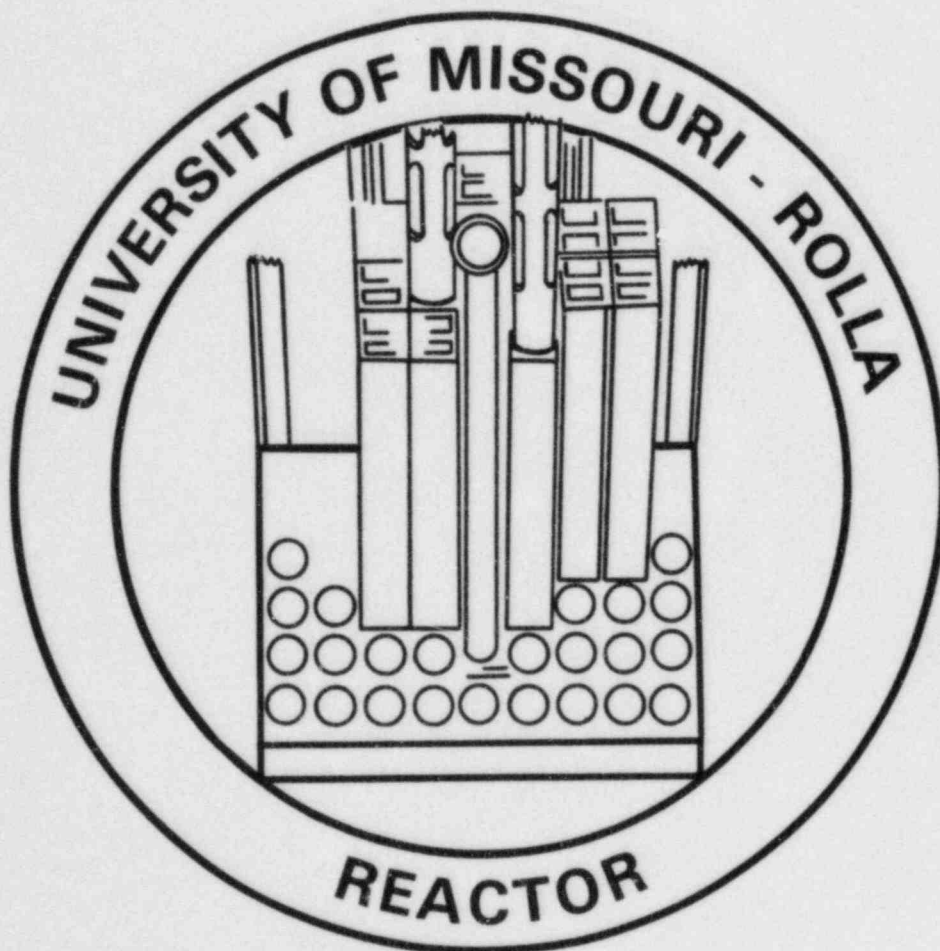


Progress Report

1984-1985

University of Missouri-Rolla

Nuclear Reactor Facility



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

APRIL 1, 1984 to MARCH 31, 1985

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

By
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Summary

During this reporting period the nuclear reactor at the University of Missouri-Rolla was in operation for about 526 hours. The major part of this time, 78%, was used for class instruction and training purposes. About 8% of the reactor time was used for research and irradiation and 14% was needed for the maintenance runs.

There were 44 UMR students enrolled for courses at the Reactor Facility. The facility was thus committed to over 52 student-hours of classes during the summer, fall, and spring semesters. The reactor was visited by about 2100 visitors during the past year. Their response to the facility and its mission is usually very positive. An educational program was established for students and their instructors from colleges and universities which do not own a nuclear reactor. The Reactor Facility is reimbursed for this program from the Reactor Sharing Program funded by the Department of Energy. There were about 50 participants in this program.

The reactor produced approximately 9.4 MW-hrs of energy using about 0.5 g of U-235. A total of 121 samples were irradiated during this reporting period with most of them being analyzed at the Reactor Facility. The reactor staff successfully accomplished the process of the license renewal for the UMR Reactor. The operating license has been renewed until November 20, 1989.

Research activities at the reactor concentrated on further improvements in the trace element analysis. Three research projects for material irradiation and neutron activation analysis were performed for on-campus investigators. Both the reactor staff and equipment were necessary to support these research projects.

Four one-week training programs for reactor operator trainees of a Midwest utility were organized during this reporting period. The reimbursement helps to defray the facility costs and also to improve its research and instructional capabilities. A paper on the facility uses for various training programs was presented at the International Education Conference in Rochester, NY.

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I. Introduction

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

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

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

II. License Renewal

The license to operate the UMR Reactor was renewed on January 14, 1985 and is valid until November 20, 1989. During the review proceedings the NRC was asked for an additional ten years extension of the operating license. The notice of this application was published in the Federal Register on February 13, 1985.

Since the evaluation period in the NRC Safety Evaluation Report for the UMR Reactor extends beyond 1989, the reactor staff expects that the application for the license extension can be accomplished with the minimum time and effort.

III. Reactor Staff and Personnel

A. Reactor Staff

<u>Name</u>	<u>Title</u>
Albert E. Bolon	Director
Milan Straka	Reactor Manager
Daniel Carter ¹⁾	Reactor Maintenance Engineer
Carl Barton	Senior Electronic Technician
Karen Lane ²⁾	Senior Secretary
Juls Williams	Lab Mechanic
Scott Linn ³⁾	Student Assistant Level II
Francis Jones ⁴⁾	Reactor Maintenance Engineer
Bryan Daiber ⁵⁾	College Work Study Student
Robert Savage ⁵⁾	College Work Study Student
Gail French ⁶⁾	Senior Secretary

B. Licensed Operators

<u>Name</u>	<u>License</u>
Albert E. Bolon	Senior Operator
Daniel Carter ¹⁾	Senior Operator
Carl Barton	Senior Operator
Karen Lane ²⁾	Reactor Operator
Milan Straka ⁷⁾	Senior Operator

-
- 1) terminated on May 24, 1984
 2) terminated on June 1, 1984
 3) terminated on April 22, 1984
 4) started on October 22, 1984
 5) started on August 20, 1984
 6) started on July 9, 1984
 7) effective on December 13, 1984

C. Radiation Safety Committee

<u>Name</u>	<u>Department</u>
Dr. Nord L. Gale (chairman)	Life Sciences
Mr. Ray Bono (secretary) (ex officio)	Environmental Health and Risk Management
Dr. Ernst Bolter	Geology and Geophysics
Dr. Oliver K. Manuel	Chemistry
Dr. Albert E. Bolon	Reactor Director
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Dr. Edward Hale	Physics

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

D. Health Physics

<u>Name</u>	<u>Title</u>
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Mr. Ray Bono ¹⁾	Director, Environmental Health and Risk Management
Mr. Jim Little	Health Physics Technician

1) title and position changed January 1, 1985 from Campus Health Physicist to Director, Environmental Health and Risk Management

E. Independent Audit

Two independent audits of the facility consisting of reviewing records, procedures, and operating methods were performed during the reporting period. Reports about both audits are enclosed in Appendix A.

IV. 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.

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.

V. 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) One additional staff member became licensed by the NRC. The facility has now 3 Senior Reactor Operators and 1 Reactor Operator Trainee.
- 2) The Multichannel Analyzer is being interfaced with a Apple II⁺ computer.
- 3) A moveable proportional neutron counter was installed in order to study geometry effects on the 1/M-curve.
- 4) A file system for the Standard Operating Procedures was created using the Apple II⁺ computer.
- 5) A new Safety Analysis Report has been compiled and approved by the NRC during the course of the license renewal process.

VI. Reactor Operations

A. Facility Use

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

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

Table 1. UMRR Core Configuration and Rack Storage Form

DATE 31 March, 1985LOADING NUMBER 67T or 67W*

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

RACK STORAGE FACILITY

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

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

BRIDGE SIDE

UMRR CORE STATUS

KEY TO PREFIXES

F - Standard Elements

C - Control Elements

HF - Half Front Element

HR - Half Rear Element

S - Source Holder

Other BRT- Bare Rabbit Tube

CRT- Cadmium Rabbit Tube

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

Total Mass Grams 2869.744

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

Table 2.

Use of Core Grid Plate Locations

<u>Location</u>	<u>Hours</u>
B4	0.483
B6	0.417
C3	0.250
C5	1.083
C7	10.767
C8	0.500
D2	0.167
D5	2.167
D8	1.700
D9	0.383
E5	0.467
E8	0.167

Table 3.
Other Facilities

<u>Facility</u>	<u>Hours</u>
Bare Rabbit Tube	21.72
Beam Port	1.28
Reactor Console	484.76
<hr/>	<hr/>
Total	507.76

Table 4.
Reactor Utilization

Reactor use	526 hr
Research & Irradiation runs	43 hr
Instruction runs	410 hr
Maintenance runs	73 hr
Time at power	209 hr
Heat generated	9418.86 kW-hr
Total number of samples	121 hr
Sample hours	88.22 hr
Research & Instruction usage ⁽¹⁾	21.8 hr
U-235 burned	0.411 g
U-235 burned and converted	0.485 g

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

Table 5a.

Rundowns

<u>Date</u>	<u>Time</u>	<u>Cause</u>
4-18-84	1458	Apparent spurious signal.
5-18-84	0928	(120% demand) Moved fuel element close to Linear CIC.
5-18-84	0938	(120% demand) Moved fuel element too close to linear detector.
6-12-84	0920	(120% demand) Student operator switched micro-microammeter the wrong way.
6-21-84	1011	(120% demand) Switched scales before recorder reached the proper level.
6-22-84	1447	Hi Rad channel noisy, no radiation was found.
7-6-84	1520	Less than 15 Period while trying to calibrate ss rod no. 3.
9-25-84	1431	Reg Rod on insert limit on auto. Cautioned operator.
10-8-84	1003	(120% demand) Linear not switched to higher scale.
10-23-84	1504	(120% demand) Due to noise on linear channel.
10-30-84	1423	(120% demand) Due to moving void tube past Linear CIC.
10-30-84	1455	Less than 15 Period due to moving void tube past Log N CIC.
11-1-84	1539	(120% demand) Due to moving void tube past Linear CIC.
11-8-84	1031	Hi Rad rundown. Checked with PIC-6A. No high level radiation. Reading on demin. channel dropped immediately to 9 mrem.
11-14-84	0951	(120% demand) Due to turning scale wrong way.
11-14-84	1030	(120% demand) Due to trainee not switching scales.
12-4-84	1017	(120% demand) Due to operator switching scales the wrong way.
12-11-84	1357	(120% demand) Due to student operator turning scale the wrong way.
12-17-84	1155	(120% demand) Due to operator turning scale wrong way.

Table 5a. (continued).

Rundowns

<u>Date</u>	<u>Time</u>	<u>Cause</u>
12-17-84	1221	Reg Rod on insert limit on Auto. Operator went into Auto with rod on insert limit.
2-1-85	1504	(120% demand) Student operator switched linear wrong way.
2-21-85	1439	(120% demand) Student kicked cable on connector on bridge.
3-29-85	1239	Power fluctuation caused 120% demand on linear.

Table 5b.

Scrams

<u>Date</u>	<u>Time</u>	<u>Cause</u>
4-11-84	1041	Loss of console power. *Staff was notified not to turn equipment on or off while reactor was operating. Unnecessary loads were removed from regulated power.
5-2-84	1101	Intentional for Emergency Evacuation drill.
10-8-84	1614	Intentional for Training purposes.
11-15-84	1033	Intentional for Training purposes.
1-4-85	1130	Intentional for Training purposes.
1-22-85	0941	Less than 5 sec. period and 150% full power while check connections for noise on period channel.
1-29-85	1539	Intentional for Training purposes.
1-30-84	1500	Intentional for Training purposes.
2-7-85	1446	Intentional for Training purposes.
2-26-85	1430	Intentional for Training purposes.
3-19-85	1235	Magnet No. 3 current causing all three rods to drop. Magnet No. 3 fuse blown. Replaced fuse.
3-29-85	0937	Due to power fluctuation. Causing regulated power to trip.

Table 6.
Maintenance

<u>Date</u>	<u>Time</u>	<u>Event</u>
6-1-84	0900	Removed magnet No. 3 found coil open.
6-4-84	1400	Coil rewound and magnet installed on reactor.
7-5-84	0730	150% full power alarm. Reactor not operating. R16 in safety amp changed values. Replaced R16.
7-6-84	0745	No magnet power. Replaced R16 again.
9-10-84	1130	Removed broken demineralizer probe in pool side of demineralizer.
9-12-84	1300	Moved probe from demineralizer outlet side to inlet side (pool side).
12-10-84	0915	Magnet No. 1 not operating. Magnet No. 3 contact light not operating. Changed V3 and V5 in magnet power supply.
12-20-84	0929	Magnet No. 1 not picking up rod. Checked magnet power supply. Changed V3 and V5. Magnets operating except for No. 1 and No. 2 contact lights.
1-21-85	1045	Reg rod limit switch (insert) inoperable. Replaced switch.
1-22-85	2035	Set point on linear recorder not properly set. Repositioned set point.
1-28-85	0853	Linear noisy. Cleaned switch.
1-28-85	0918	Linear noisy. Replaced signal cable from bridge and linear amp.
2-1-85	1030	Conductivity cell replaced in demineralizer outlet.
2-25-85	0904	Magnet current on No. 1, 2 and 3 erratic. Replaced adjust pot. on both No. 1 and 2 magnet current. Also replaced S2 (magnet current switch).

Table 6. (continued).

Maintenance

<u>Date</u>	<u>Time</u>	<u>Event</u>
2-25-85	1500	Found wire broken on power voltage point. Resoldered wire.
2-28-85	0945	Removed bare rabbit tube and replaced tubing. Replaced bare tube in proper place.
3-5-85	1130	Found magnet No. 2 current decreases while current is energized. Replaced V4 (magnet current tube) in safety amplifier.

Table 7.

Core Loading and Unloading*

<u>Date</u>	
4-17-84	UL (67W to subcrit) to prepare to determine critical mass in 67W mode.
4-17-84	RL (subcrit to 67W) to determine critical mass in 67W.
4-18-84	UL (67T to subcrit) to prepare to determine critical mass in 67T mode.
4-18-84	RL (subcrit to 67T) to determine critical mass in 67T mode.
4-19-84	UL (67T to subcrit) to prepare to determine critical mass in 67T mode.
4-19-84	RL (subcrit to 67T) to determine critical mass in 67T mode.
5-15-84	UL (67W to subcrit) to inspect control rods.
5-18-84	RL (subcrit to 67W) return to previous configuration.
9-18-84	UL (67W to subcrit) to prepare to determine keff in storage pool area.
9-19-84	(subcrit to subcrit) moved fuel elements to different locations to determine keff of storage pool.
9-20-84	(subcrit to subcrit) continuation to determine storage pool keff.
9-21-84	(subcrit to subcrit) continuation to determine storage pool keff.
9-24-84	(subcrit to subcrit) continuation to determine storage pool keff.
9-24-84	RL (subcrit to 67W) reload to original 67W mode.
11-9-84	UL (67W to subcrit) fuel handling practice taught to operator trainees from Arkansas Power & Light.

* UL - unload
RL - Reload

11-9-84 RL (subcrit to 67W) reload to previous configuration.
11-16-84 UL (67W to subcrit) same as above, operator training.
11-16-84 RL (subcrit to 67W) reload to previous configuration.

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 and thermal column experiments. The excess reactivity was measured for cold, clean critical conditions. In day-to-day operation the excess reactivity is quite often lower due to the temperature increase of the pool.

Table 8. Core Technical Data

Average Thermal Flux	1.6×10^{12} n/cm ² -sec at 200 kW		
Maximum Thermal Flux	2.8×10^{12} n/cm ² -sec at 200 kW		
Average Epithermal Flux	1.6×10^{11} n/cm ² -sec at 200 kW		
Worth of Thermal Column	0.46%		
Worth of Beam Port	not detectable		
Rod Worth (in "T" mode)			
Date <u>4-16-79</u>	<u>4-16-79</u>	<u>4-16-79</u>	<u>10-10-83</u>
I <u>2.64%</u>	II <u>2.65%</u>	III <u>3.36%</u>	Reg. <u>0.347%</u>
Excess Reactivity (in "T" mode) <u>0.73%</u> Shutdown Margin (in "T" mode) <u>4.56%</u> .			
Void Coefficient <u>-7.7×10^{-7} ρ/cm^3</u> Date <u>10-30-84</u>			
Temperature Coefficient <u>-1.3×10^{-4} $\rho/^{\circ}\text{F}$</u> Date <u>11-20-84</u>			
Reactivity Addition Rate (max % $\Delta K/K/\text{sec}$)			
I <u>0.019</u>	II <u>0.019</u>	III <u>0.026</u>	Reg. <u>0.01</u>
Rod Drop Time (24")			
I <u>495 msec,</u>	II <u>480 msec,</u>	III <u>495 msec,</u>	Date <u>9-7-84</u>
Magnet Separation Time (at I_{max})			
I <u>27 msec,</u>	II <u>31 msec,</u>	III <u>36 msec,</u>	Date <u>9-7-84</u>

VII. Public Relations

The reactor staff continues to put forth considerable effort to help educate the public about the application of nuclear energy. Over 2,077 persons have toured the facility during this report 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 of the groups have spent an entire day at the facility becoming acquainted with the reactor and performing simple experiments. Usually these groups are from colleges which have no reactor facilities. A guided tour by the reactor staff includes a brief description of the basic nuclear reactions, components of a nuclear reactor, a few specific examples of how nuclear energy is used in the industrial and educational fields and how nuclear energy helps the environmental situation.

One staff member participated in the International Nuclear Education Conference in Rochester, NY, presenting a paper about the facility's training program for Reactor Operators.

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.

VIII. Educational Utilization

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

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

NE 2	Introduction to Nuclear Engr. II	9.4
NE 304	Reactor Laboratory I	41.3
NE 306	Reactor Operations	185.5
NE 308	Reactor Laboratory II	62.3
83-1	Glass Optics	4.3

The current enrollment in Nuclear Engineering is 68 students.

A program called Reactor Sharing Program, funded by the Department of Energy, was established for colleges and universities which do not own a nuclear reactor. About 50 students and their instructors participated in this program.

IX. Reactor Health Physics Activities

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

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, 3 shipments of by-product material were surveyed and released from the reactor facility. Total activity released was 0.011 mCi. One shipment was low-level waste transferred to the UMR Hazardous Waste storage building. The second shipment was a radioactive device returned to the originator and the third shipment was by-product material used on campus.

Routine Monitoring

Twenty-seven reactor facility personnel and students frequently involved

with operations in the reactor facility are currently assigned beta-gamma, neutron film badges which are read twice each month. There are 4 beta-gamma, neutron area badges assigned and one test badge to check accuracy of exposure reports. Fourteen campus personnel and students are assigned beta-gamma film badges, and frequently TLD ring badges for materials and X-ray work on campus. There are 13 beta-gamma area and spare badges assigned on campus. In addition, 7 direct-reading dosimeters are used for visitors and high radiation area work. There have been no personnel over exposures during the period.

Airborne activity in the reactor facility is constantly monitored by a fixed-filter, particulate continuous air monitor (CAM) located in the reactor bay. Argon-41 is 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 $8.04 \times 10^{-6} \mu\text{Ci/ml}$.

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 19.38 millicuries were released into the air. Released isotopes were identified as Ar-41. Solid waste, including used water filters, used resins and contaminated paper is stored and/or transferred to the campus waste storage area for later shipment to a commercial burial site. Radioactive waste released to

the sanitary sewer is primarily from regeneration of the resin exchange column. During this period 10 releases to the sanitary sewer totaling approximately 4650 gallons of concentrated resin regeneration solution and pool water were discharged with a total activity of 0.271 millicuries. No peaks were identified during the analysis.

Instrument Calibrations

During this period, portable instruments were calibrated four times.

Remote area monitors were checked for calibration four times.

X. Plans

Now that the license renewal process has been completed, the reactor management plans to spend more time and effort upgrading the facility's research capability. Although extra efforts have been made to inform academic department chairmen and research center directors of the current availability of the reactor and the various associated counting systems, we have not generated very much research activity. We also try to inform the individual faculty members/researchers, who we believe might be doing research that could utilize the UMR Reactor, that we would be pleased to cooperate with them. A six-member Reactor Research Advisory Committee has been established to assist the reactor management with ideas for research. The purpose of the committee is to have a knowledgeable group of faculty/researchers who would advise the reactor staff regarding areas of potential research and regarding equipment needed in order to develop proper research capability. The specific objectives of the committee are as follows:

1. To more fully utilize the present research capabilities of the UMR reactor.
2. To improve communications and interactions between the faculty and graduate students and the reactor staff.
3. To develop new research projects based upon the interaction of nuclear reactor-related radiation (ie. neutrons and/or gamma rays) and matter. Such projects could be either neutron activation analysis (NAA) or radiation damage or effects.

4. To determine the facility modifications or equipment additions needed in order to improve the research capabilities of the UMR Reactor.

A five-year research plan for the Reactor Facility was prepared by the Reactor Director and submitted to the Dean. In order to develop a quality research program at the UMR Reactor over the next five years, financial support in the amounts as shown in Table 9 would be needed.

Table 9. Additional Engineering Research and Equipment Support Needed for the UMR Reactor Facility For the Next Five Years (in '85 dollars)

<u>Needs</u>	<u>Fiscal Year</u>				
	<u>'87</u>	<u>'88</u>	<u>'89</u>	<u>'90</u>	<u>'91</u>
Research Equipment	15,000	15,000	15,000	15,000	15,000
Instructional Equipment	5,000	5,000	5,000	5,000	5,000
Other					
Grad. Res. Asst.	16,400	16,400	24,600	24,600	32,800
Post-Doc. Fellow		22,000	22,000		22,000
Senior Researcher				50,000	50,000
Supplies	3,600	5,800	6,700	9,500	12,500
Total	40,000	64,200	73,300	104,100	137,300

The grand total for the 5-year program would be \$418,900. By the end of the five-year period there would be a research staff of four half-time graduate research assistants, one post-doctoral fellow, and one senior researcher in addition to the present number of operational staff. If properly done, some of the funding could be provided by external sources.

The specific research equipment needs of the Reactor Facility are listed in Table 10.

Table 10. Research Equipment Needs
Of the UMR Reactor Facility (in '85 dollars)

<u>Item</u>	<u>Estimated Cost</u>
Intrinsic Germanium Detector	\$10,000
Microcomputer-based Multichannel Analyzer	16,500
Isotope Identification Package	3,000
Printer/Plotter	2,000
Total	<hr/> \$31,500

The instructional equipment needs are shown in Table 11.

Table 11. Instructional Equipment Needs
Of the UMR Reactor Facility (in '85 dollars)

<u>Item</u>	<u>Estimated Cost</u>
Intrinsic Germanium Detector	\$10,000
Canberra Series 85* Multichannel Analyzer	9,400
Daisey Wheel Printer	1,000
Linear Micromicroammeter	3,000
Digital Pulse Generator	1,800
Curve Tracer	700
X-Y Plotter	1,960
X-Y Plotter Interface	460
Eberline Rascal* Neutron Meter	3,000
Air Sampler	1,200
Total	<hr/> \$32,520

* or equivalent

The two previous tables do not necessarily total the amount needed in Table 9.

In conclusion, for a reasonable sum of money the UMR Reactor could be developed into a viable research facility which could benefit the mid-west region of the nation. By the end of the 5-year program the research staff would be built up to a level so that they could be self-supporting on research grants and contracts.

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

The U.S. Department of Energy supports the UMR Reactor through the University Reactor Sharing Program. We received \$9000 financial support this past year. Several groups from Linn Technical Institute have come or will come to campus for a day each. The University of Arkansas will send a graduate student or two for two days in April. Other schools are expected to use the reactor for education or research before the end of the contract in August. We hope to be selected for an extension of that program.

Reactor management's plan to have at least three licensed senior operators has been accomplished.

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

APPENDIX A

Independent Audits

REC'D FEB 27 1985



UNIVERSITY OF MISSOURI

A-1

Research Reactor Facility

February 25, 1985

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

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

Dear Dr. Bolon:

On Monday, February 11, 1985, Nolan Tritschler and I conducted a Reactor Facility Inspection of the UMR-Reactor. This inspection concentrated on several areas given in your independent audit form. The summary comments from the inspection from each of us are attached to the audit form. There may be some duplication between our comments since we discussed several items while we were there.

We found no major areas of concern with the UMRR operations and noticed many improvements concerning past audit comments. We think that a new audit form might be in order to reflect the references to the new technical specifications. The current form leaves quite a bit of uncertainty as to what exactly the auditor should be looking for in several categories.

We would appreciate receiving a copy of the most current SOP's so we will be ready next time you need us to come down. We thank Milan Straka and Butch Jones for their help in performing this audit.

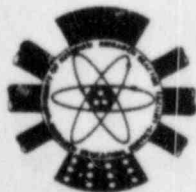
Sincerely,

A handwritten signature in dark ink, appearing to read 'Walt A. Meyer, Jr.'.

Walt A. Meyer, Jr.
Reactor Operations Engineer

WAM:vs

Attachments



COLUMBIA KANSAS CITY ROLLA ST. LOUIS

an equal opportunity institution

February 11, 1985 AUDIT COMMENTS (WALT MEYER)SURVEILLANCE REQUIREMENTS

We reviewed the quarterly, semiannual and annual surveillance performed in November and December, 1984. This included RAM calibration (Q), HP Instrument Calibration (Q), Emergency Drill (S), Requalification Review (S), Pool Water H₃ Analysis (S), Void Coefficient Measurement (A), and Temperature Coefficient Measurement (A). All were performed within specified time intervals. The void coefficient and temperature coefficient were done by a student laboratory report reviewed by Dr. Bolon and M. Straka. This provides adequate control by management as long as the reviews are performed. The review of the void coefficient had not yet been performed by management. The process of obtaining these coefficients appears to be valid, however their performance is not specifically tied to the Standard Operating Procedures for these checks (SOP 303, SOP 304).

REQUALIFICATION

We reviewed the requalification records and most recent tests and found no discrepancies. The performance evaluation forms are now filled out completely.

One question we had involved the fact that all three operators took their requalification test on separate dates (Dr. Bolon 8/21/84, M. Straka 8/28/84, C. Barton 7/13/84). This might raise the question of the security of the content of these tests unless all three tests are different (i.e., an operator might know the content of the test in advance).

UMRR HOURLY OPERATING LOGS (SOP-104)

As a follow up item, we reviewed the hourly operating logs for completeness. We found on several occasions that no senior operator had reviewed the logs at the end of the day (8/30/84, 9/5/84, 10/10/84, 11/9/84, 2/8/85).

There also were numerous occasions when no licensed operator was signed in at the beginning of the day. We felt it might be more significant to have a licensed signature, than multiple student signatures.

UMRR PRE-STARTUP CHECKLIST (SOP-102)

This sheet was revised 9/4/84 to incorporate the inclusion of the date on the second page. We found no problems with these checklists.

UMRR SHUTDOWN CHECKLIST (SOP-105)

Our review found no problems with these checklists.

WEEKLY SURVEILLANCE CHECKLIST (SOP-811)

Our review of these checklists found no major problems. On September 5, the test of annunciators has a blank in the space for checking Beam Room High Neutron Flux.

STANDARD OPERATING PROCEDURES

We were somewhat handicapped by the fact that the SOP's with which we had familiarized ourselves, were out of date by four months. The 9/4/84 revision appeared to change about half of the SOP's. In this regard, we would appreciate receiving an up-to-date complete SOP, so we can be better prepared next time.

The proper reviews by licensed personnel for all SOP changes appeared to have been made in a timely fashion. We found it difficult in comparing our out-of-date SOP to the new SOP to determine which SOP's were current. One suggestion might be to include the use of a list of effective pages to show which pages are current after each revision.

We also could not determine how a "controlled" SOP copy could be distinguished from a "non-controlled" copy.

Submitted by:

Walt A. Meyer, Jr.
Reactor Operations Engineer

February 11, 1985 AUDIT COMMENTS (Nolan Tritschler)

1. Recommend implementation of unscheduled shutdown checksheet. This should aid in recovering information for recurring problems, maintenance, monthly reports, etc. Also would allow much fuller explanation of events than is currently exercised in the console log.
2. Suggest some method be formed to test the operability of the power range NI after maintenance or replacement before startup of the reactor. I feel that the detector could be bugged in some manner although the existing neutron source is not strong enough to serve this purpose.
3. Recommend the addition of an overlay or some other method of determining the slope of the trace on the log count rate recorder during startup to assure that the 45° slope limit is not exceeded. At this time, this is being done by eyeball only. One possibility is the placing of 45° lines on the back of the recorder door glass as a reference.
4. Console log entries pertaining to who is on shift, what evolutions are being performed, etc., have been an item of comment on previous audits. It shows that some progress has been made in this area, however, it still needs attention as the improvements are rather spotty. One action in particular is the use of bypass keys; these are to be used only by a senior reactor operator. Due to the spotty log entries, it is, at times, impossible to determine if there is a senior reactor operator in the building much less in control of the bypass key usage. I recommend that when a bypass key is used or removed, this action should be entered in the console log and initialed by the senior reactor operator.

5. On 12-12-84, an evacuation drill was performed and according to the log it took three minutes to carry it out. It would seem that this is an overly long time to clear a facility of this size. Some steps should be taken to expedite this exercise. A time interval of no longer than 1-1/2 to 2 minutes should be a good goal.
6. Another area of concern is the hourly logs. At the top of the form are blanks for the operators to be named and/or signed in. Upon examination, no reactor operator or senior reactor operator had been entered on many occasions, in fact, not one had been entered from 1-25-85 to 2-8-85 even though the reactor had been operated several times. Students had been entered regularly however, this is rather irrelevant. On 1-22-85, PRM readings were taken in error on at least four power level readings by a student. The operators must understand that they are the ones with the licenses, not the students. The students are merely an extension of their own, and they need to monitor such activities very closely as they are ultimately responsible and should review and initial each and every set of readings.
7. On 1-24-85, the reactor was operated up to a power of 190KW. At this time, it was decided that the reactor should be shut down because the detectors were badly misaligned. On the same afternoon, the reactor was again operated at power levels up to 200 KW (full power) without anything having been done about the detectors. On 1-25-85, the detectors were aligned. It would seem that if the misalignment was bad enough to warrant a shutdown, then the reactor should not have been operated at full power until this was corrected.

8. Lastly, it was felt that the S.O.P.'s are very cumbersome and contain a good deal of superfluous instruction, i.e., wash windows, empty trash, etc. They also contain several errors both typographical and genuine. One was the formula for calculating void coefficient - it just won't work as written. (S.O.P. 303, page 2 of 2, revised 7-22-75, says:

$$3 \times 10^{-6} \frac{\Delta K}{K} = 3 \times 10^{-7} \frac{\Delta K}{K} "$$

This may have been corrected by 9/4/84 revision.)

<u>Survey Instrument</u>	<u>Calibration Done</u>
E-120 #9755	11-21-84
Room 14	11-21-84
GM E-120 #3194	11-21-84
GM Thyar-389 #24513	005
PIC 6A 1405	11-21-84
PIC 6A 1799	11-21-84
PIC 6A 1851	11-21-84
H.R. RADEC III	11-21-84 could not calibrate (00S ?)
NEUT Vic 488A	1-18-85

All of the above instruments had been calibrated or removed from service as required, "I think". The one exception was the H.R. RADEC III which was noted on 11-21-84 that it could not be calibrated. We could not determine if it had been removed from service or not.

My general impression was that the facility is run by a knowledgeable group of people in a rather relaxed manner. So, I don't think that criteria is not being followed as much as the documentation is just sketchy in places. Enjoyed the opportunity to visit.

Submitted by:

Nolan Tritschler
Reactor Shift Supervisor

A-7
Independent Audit

REACTOR FACILITY INSPECTION -- Date(s) February 11, 1985
(Phone: 341-4236)

Date(s) of last NRC inspection not checked

Date(s) of last "inhouse" inspection June 18, 1984

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	<u>6</u>	<u>127</u>	<u>May 17, 1984</u>
Through entry:	<u>6</u>	<u>210</u>	<u>Feb 8, 1985</u>

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

Hourly Operating Log Senior Operator Signature
Use of Bypass Keys (Documentation of SO)
Completeness of Regual Performance Evaluation

	OK	Comments
A. Technical specifications----- Appendix A -- Jan. 6, 1967		current tech specs - Dec, 1984
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-----	not checked	
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% < ρ_{ex} < 3.5% five consecutive days twice a year-----		Dates: (1) _____ (2) _____
7. Control rod: (9.5) condition-----		Date Inspected: _____
(4.2.3) Reactivity shutdown margin at least 8% -----		(9.3) Dates: (1) _____ (2) _____
(4.2.4) Drop time < 600 msec-----		
(4.3.2) Limit lights; shim range lights, magnet contact lights-----		
8. Neutron source (min. 10^6 n/sec----		

not checked

	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	N/A	not in new tech specs.
11. (5.7) Radiation levels <0.1 mr/hr		<div>Location</div> <div>Pool surface above core</div> <div>Near demineralizer</div> <div>Beam room</div> <div>Reading</div>
12. (5.8) Portable survey instruments		
List:		
Neutron	Alpha	these instruments and calibration data are included in attached summary.
Gamma	Beta	
Other		
13. Experimental facilities-----		Give example as to how it is 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: ρ_{ex} <0.7% -----		
(6.2.4) Single movable experiment: ρ_{ex} <0.4% -----		
0.6% all movable exp.----		
(6.2.5) Experiments having moving parts: ρ_{ex} <0.05%-----		
(6.2.6) Position of any/all exp.--		
14. General Operating Limitations		
(7.1) Startup: Sr. Oper. plus one (in the control room)	✓	
(7.1) Operation: S.O. plus one (in building)	✓	
(7.4) No fuel position vacancies in core; loading (wall chart)-----	✓	

	OK	Comments
15. Fuel Storage & Transfer	✓	
wall chart -----	✓	
(8.3) Fuel handling tools locked--	✓	
(8.4) Fuel transfer--three men	✓	separate checklist
(Sr.Oper.; Lic.Oper.; plus one----		
16. (10.1) New loading: approach to		
critical exp.(reason & date)-----		
(10.2) Core configuration change:		
one grid position. (Reason & date)		
(10.3) Loading change of more than		
one grid position-unload 50%-----		
17. Instruments functioning (Table I)-		(On weekly check list - *)
Scram: Manual-----	✓	startup
Period <5 sec.-----	✓	*
150% full power-----	✓	startup
Bridge motion-----	✓	*
Log N- Period non-op-----	✓	*startup
Rundown: 120% power (linear)-----	✓	*
Period <15 sec -----	✓	*
Reg Rod (insert limit-auto	✓	
rundown)		
120% full power (log N)---	✓	*
Low CIC voltage-----	✓	startup
High radiation-----	✓	startup
Rod prohibit: Period <30 sec-----	✓	*
Any recorder off-----	✓	*
Low count rate-----	✓	*
Reg Rod prohibit (rods	✓	
below shim range)-----	✓	
Inlet temp.> 135°F-----	✓	*
Servo-prohibit on reg. rod-----	✓	
18. Check Lists and records		
Log book checked-----	✓	
(9.1) Daily facility check list---	✓	Dates: (1) _____
(9.3) Instrument channels & area	✓	(2) _____
monitors-calibrated at 90 day		(3) _____
intervals-----	✓	(4) _____
UMRR startup check list-----	✓	
Hourly records-note variations---	✓	
Shut-down check list-----	✓	
Weekly check list-----	✓	
Work load log-----	✓	
Six month systems check-----	✓	Dates: (1) _____
		(2) _____

	OK	Comments
B. Records		
1. Log books-----	✓	Current book number <u>6</u> Other <u>Stored</u>
2. Recorder charts----- Log N (permanent)-----	not checked	Stored: where and for how long Located:
3. Evacuation alarms: number and cause-----	N/A	1.
4. Evacuation procedures, drills-		2. <u>evacuation drill 12/12/84</u>
5. Use of by-pass keys-----		1. <u>7/6/84</u> <30 sec bypassed <u>9/21, 84</u> <2 counts bypassed
6. Key security----- General security----- Night use of building-----	not checked	
7. SOP'S - Note any revisions----	✓	many new revisions - see checked list (9/4/84)
8. Film badge, dosimeter-----	✓	
9. Night watchman record-----	not checked	
C. Reactor Bay		
1. General condition of pool-----	✓	
2. General condition of storage----	not checked	
3. Use of cable trench-----	✓	
4. Nitrogen diffuser-----	✓	
5. Miscellaneous (List)-----	N/A	
D. Control Room-----	✓	
List of current operators-----	✓	Senior operators: <u>W.A. A.E. Bolan</u> <u>C.M. Barton</u>
E. Office (film badge rack, etc.)----	✓	
F. Counting Room-----	✓	Operators: <u>Milan Straka</u> <u>1/11/85</u> <u>SO</u> <u>Butch Jones (trainee)</u>
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-----	✓	appeared that upper waste tank had seepage from connections at bottom
J. Health Physics		
1. Sample removal-----		
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-----		
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

Dates:

General comments:

see attached comments.



UNIVERSITY OF MISSOURI

A-12

Research Reactor Facility

July 10, 1984

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

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

Dear Dr. Bolon:

On Monday, June 18, 1984, Charles Anderson and I conducted a Reactor Facility Inspection of the UMR-Reactor. This inspection concentrated on several areas included in your inspection form. Detailed comments from the inspection will primarily be contained in this letter, referenced from your inspection form by an asterisk (*).

A.18 Checklists and Records

1) Weekly Surveillance Checklist (SOP 811)

January 3, 1984. 120% demand rundown entry omitted.

2) Pre-Startup Checksheets (SOP 102)

- a) Weeks of January 9 and March 5; drop current rod #1 = 63 ma. Rod current set at 85 ma and 88 ma respectively. SOP 137 defines normal magnet current = drop current + 10 ma, and defines maximum magnet current = normal current + 10 ma, which implies maximum magnet current = drop current + 20 ma. This does not imply that operation is out of compliance with technical specifications (which address rod drop and separation times), it just seems that to be consistent with SOP 137, maximum operating magnet current should be as defined or have rod drops at currents exceeding maximum magnet current documented to not effect drop times significantly.
- b) When reviewing the Pre-startup checksheet, several second pages had become detached. The second page has no place for a date to tie it to a specific page one. Suggest adding date to second page.



COLUMBIA KANSAS CITY ROLLA ST. LOUIS

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Dr. Albert Bolon
July 10, 1984
Page 2

3) Material Transfer Form (SOP 604)

Consignee byproduct license blank not filled in for several dates - 3/14, 5/2, 5/3). These may be covered by UMRR byproduct license (?).

4) Semiannual Checklist

- a) Start Date - December 19, 1983
Completion Date - January 6, 1984

Several items in checklist dated outside the start to completion dates (specifically January 10, 1984).

- b) Possible error in recording data on page 7, step c. Entry for check of 2.0×10^{-7} is 6.8, should be 2.0.

5) Hourly Operating Log (SOP 104)

- a) Several Hourly Operating Logs had no senior operator signature at end of day (2/16, 3/13, 5/1, 5/10, 5/11, 5/14, 5/18, 6/12).
- b) Several startups did not list purpose of startup. This was not consistent with previous entries (3/14, 3/16, 3/21, 3/22).

B.5 Use of Bypass Keys

Console log has two entries for insertion of same bypass key, with no intervening removal of key logged (4/17).

B.7 Standard Operating Procedures

These items are detailed in section A.18 of this letter.

J. Health Physics

A detailed review of this section showed no major items of concern. The outside air sample listed on audit sheet is not being done. The Health Physics Manager no longer has a Health Physics Technician working with him to cover all campus areas.

General Comments

The operator requalification program is now subject to periodic review by the Reactor Manager which should improve documentation. One area of omission on individual evaluation sheets -- the requalification program states that "evaluator will also discuss or simulate abnormal or emergency conditions during the manipulations and grade operator on response". This does not seem to be done. One suggestion might be to discuss these conditions prior to or directly after manipulation to keep from distracting the operator during startup.

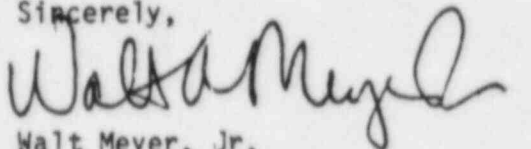
Dr. Albert Bolon
July 10, 1984
Page 3

In regards to the reactor scram due to plugging into an electrical outlet that was connected to reactor control power -- one suggestion might be to label such outlets with some caution or warning tags.

Chuck and I would like to thank you, Milan, and Mr. Barton for your assistance in locating and explaining your records.

We found your operations being conducted in a satisfactory manner with no major problem areas identified. We hope some of the suggestions are helpful.

Sincerely,

A handwritten signature in dark ink, appearing to read "Walt Meyer, Jr.", with a stylized, cursive script.

Walt Meyer, Jr.
Reactor Operations Engineer

WAM:vs

Attachment: UMRR Audit Forms

REACTOR FACILITY INSPECTION -- Date(s) June 18, 1984
 (Phone: 341-4236)

Date(s) of last NRC inspection _____

Date(s) of last "inhouse" inspection Jan 10, 1984

Log Book Inspection:

	Log Book Number	Page	Date
From entry:	<u>VI</u>	<u>81</u>	<u>Jan 10, 1984</u>
Through entry:	<u>VI</u>	<u>129</u>	<u>Jan 14, 1984</u>

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

S.O.P. Revisions

	OK	Comments
A. Technical specifications----- Appendix A -- Jan. 6, 1967	✓	
1. (2.1) Ventilating fans----- Automatic closure -----	✓	
2. (3.1) Pool water depth (16 ft. min above core)-----	✓	
3. (3.1) Inlet water temperature 60°F < t < 135°F-----	✓	
4. (3.2) Radiation one meter above pool < 5 mr/hr -----	✓	
5. (3.2) Resistivity > 0.5 megohm-cm-	✓	
6. Fuel -----	✓	Type of elements: MTR Other
(4.1.3) p ex < 1.5% -----	W/D	Present loading(s): <u>6TW & 6TT</u>
1.5% < pex < 3.5% five consecutive days twice a year-----	W/D	Dates: (1) _____ (2) _____
7. Control rod: (9.5) condition-----	✓	Date Inspected: _____
(4.2.3) Reactivity shutdown margin at least 8% -----	✓	(9.3) Dates: (1) _____ (2) _____
(4.2.4) Drop time < 600 msec-----	✓	
(4.3.2) Limit lights; shim range lights, magnet contact lights-----	✓	one not operative - SOP 305 used
8. Neutron source (min. 10 ⁶ n/sec----	✓	

not
checked
in
detail

~~* See under letter~~

	OK	Comments
9. Safety systems (annunciator)-----	✓	
(5.4) Start-up channel-----	✓	
(5.4) Linear channel-----	✓	experiencing problems with C&C
(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	✓	<div> <div>Location</div> <div>Pool surface above core</div> <div>Near demineralizer</div> <div>Beam room</div> </div> <div> <div>Reading</div> </div>
12. (5.8) Portable survey instruments		
List:		
Neutron	Alpha	checked calibration
		detectors of all instruments;
		all within last month
	Beta	except Eberline 1405, cal.
		3/27/84
Gamma		
Other		
13. Experimental facilities-----		Give example as to how it is used.
Hung samples-----		
(6.1.1) Core access element-----		
(6.1.1) Isotope prod. element-----		
(6.1.2) Rabbit tube-----		
(6.1.2) Thermal column-----		
(6.1.2) Beam port-----		
(6.2.2) Documentation of exps.---		
(6.2.3) Single independent experiment: $\rho_{ex} < 0.7\%$ -----		
(6.2.4) Single movable experiment: $\rho_{ex} < 0.4\%$ -----		
0.6% all movable exp.---		
(6.2.5) Experiments having moving parts: $\rho_{ex} < 0.05\%$ -----		
(6.2.6) Position of any/all exp.--		
14. General Operating Limitations		
(7.1) Startup: Sr. Oper. plus one (in the control room)		
(7.1) Operation: S.O. plus one--- (in building)		
(7.4) No fuel position vacancies in core; loading (wall chart)-----		

~~see also letter~~

	OK	Comments
15. Fuel Storage & Transfer	✓	
wall chart -----	✓	
(8.3) Fuel handling tools locked--	✓	
(8.4) Fuel transfer--three men	✓	
(Sr.Oper.; Lic.Oper.; plus one----		
16. (10.1) New loading: approach to		
critical exp.(reason & date)-----		
(10.2) Core configuration change:		
one grid position. (Reason & date)		
(10.3) Loading change of more than		
one grid position-unload 50%-----		
17. Instruments functioning (Table I)-		
Scram: Manual-----	✓	(On weekly check list - *)
Period <5 sec.-----	✓	startup <i>electrical load cycle - Apr 11</i>
150% full power-----	✓	* <i>suggest - may want to</i>
Bridge motion-----	✓	* <i>label electrical</i>
Log N- Period non-op-----	✓	*startup <i>outlets as Rx control</i>
Rundown: 120% power (linear)-----	✓	* <i>power outlets</i>
Period <15 sec -----	✓	*
Reg Rod (insert limit-auto		
rundown)		
120% full power (log N)---	✓	*
Low CIC voltage-----	✓	startup <i>high rad area - 8m/hu - Apr 12</i>
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---	✓	Dates: (1) _____
(9.3) Instrument channels & area		(2) _____
monitors-calibrated at 90 day		(3) _____
intervals-----	N/A	(4) _____
UMRR startup check list-----	✓	
Hourly records-note variations---	✓	
Shut-down check list-----	✓	
Weekly check list-----	✓	
Work load log-----	N/A	
Six month systems check-----	N/A	Dates: (1) _____
		(2) _____

* See Cover Section

	OK	Comments
B. Records	* ✓	
1. Log books-----	✓	Current book number <u>✓1</u>
	✓	Other <u>Stored</u>
2. Recorder charts-----	✓	Stored: where and for how long
Log N (permanent)-----	✓	Located:
3. Evacuation alarms: number and cause-----	✓	1.
	✓	2.
4. Evacuation procedures, drills-----	✓	1. May 2, 1984 evac. drill
5. Use of by-pass keys-----	✓	Consider key has entry for two bypass keys inserted w/no intervening removal logged - Apr 17
6. Key security-----	✓	Several revisions made, notably 100 series (reactor logs)
General security-----	✓	600 series (rad. protection)
Night use of building-----	✓	SOP 501 updated to include m. STANKA for notification
7. SOP'S - Note any revisions-----	* ✓	SOP 604 - material Transfer form - consignee byproduct license # blank - 5/14
		5/2
		5/3
8. Film badge, dosimeter-----	✓	
9. Night watchman record-----	✓	
C. Reactor Bay		
1. General condition of pool-----	✓	
2. General condition of storage-----	✓	
3. Use of cable trench-----	✓	
4. Nitrogen diffuser-----	✓	
5. Miscellaneous (List)-----	✓	
D. Control Room-----	✓	
List of current operators-----		Senior operators: DR. ALBERT BOLAN Apr 6, 1982 C.M. BARTON Sept 9, 1983
E. Office (film badge rack, etc.)-----	✓	
F. Counting Room-----	✓	Operators: M. STANKA Sept 22, 1983
G. Rooms & Storage upstairs-----	✓	
	* ✓	documentation Regul program being updated (m. STANKA is instituting review of regul documentation)
	* ✓	see cover letter

	OK	Comments
H. Stairwell & pump area-----	✓	
1. Demineralizer system-----	✓	
2. Outside air filters-----	✓	
I. Stairs and beam room-----	} not checked	
1. Thermal column-----		
2. Beam tube-----		
3. Fuel storage-----		
4. Liquid & solid waste storage-----		
J. Health Physics		
1. Sample removal-----	✓	
2. SOP'S (list)-----	✓	Recently revised, May 1984
3. Excursion or incident monitor-----	✓	Bridges placed throughout building
a. Film badge placement-----	✓	at RAMS - processed every two weeks
b. Other-----	✓	
4. Film badge, dosimeter records-----	✓	LAWRENCE BRIDGE SYSTEM
a. Staff-----	✓	dosimeter - logged in guest book
b. Students-----	✓	
c. Guests-----	✓	dosimeter - self logged in Night Watchman's log
d. Night watchman-----	✓	
5. Possible detection of fuel element rupture-----	✓	Exam above pool - pool water sample
6. Radiation survey-----	✓	Dates:
a. Periodic swipe tests-----	✓	
b. Pool water-----	✓	continuous particulate monitor
c. Inside air-----	✓	and fresh samples
d. Outside air-----	✓	outside not performed
e. Neutron level (sub-critical)-----	✓	
f. Misc. items (list)-----	✓	
7. Emergency box (Physics Bldg.)-----	✓	inventory yearly

General comments:

See cover letter

Walt Meyer

APPENDIX B

Semi-Annual Checks (SOP 300)

Semi Annual Check List

Date Commenced DEC 2 1983Date Completed JAN 2 1984Total Hours on Hour Meter 09054.0

1. Log N and Period Channel

Initial

JAN 1984

a. Nog N Power Supply

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

NONE

CMB

CMB

b. Log N Recorder

Date JAN 1984

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

NONE

CMB

CMB

c. Neutron Detector Check

Resistance (ohms)

Capacitance (pf)

JAN 1 1984

(1) Signal to ground

6.7 x 10¹¹1129 pfCMB

(2) Positive to ground

6.8 x 10¹¹1214 pfCMB

(3) Negative to ground

6.8 x 10¹¹1194 pfCMB

d. Log N Calibration

Date JAN 7 1984

Initial

1. Meter

Recorder

Keithley

100

100 5×10^{-3} CMB

10

8 3.5×10^{-6} CMB

1

1 4.5×10^{-7} CMB

0.1

0.1 5×10^{-8} CMB

.01

0.012 5×10^{-9} CMB

.001

0.0012 5×10^{-10} CMB

.0001

0.0002 5×10^{-11} CMB

Reconnection of Cables Verified

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

e. Period Recorder

Date JAN 7 1984

(1) Cleaned chassis

CMB

(2) Tested all vacuum tubes

CMB

Replaced:

tube #

tube type

NONE

2. Linear Power Channel

a. Linear Power Supply

Date JAN 11 1984

(1) Cleaned chassis

CMB

(2) Tested all vacuum tubes

CMB

Replaced:

tube #

tube type

NONE

b. Linear Recorder

Date JAN 1 1985

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #tube type

1101E

CMH-3

CMH-3

c. Micro-Micro Ammeter (Spare)

Date JAN 1 1984

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #tube type

*

CMH-3

CMH-3

* $\frac{1}{2}$ and $\frac{1}{2}$ Tube ass. m b) y (Preamp) was used in SN 18650.

d. Linear Neutron Detector Check

JAN 1 1985

	Resistance (ohms)	Capacitance (pf)	
(1) Signal to ground	<u>2.2×10^{10}</u>	<u>1222 pf</u>	<u>CMH-3</u>
(2) Positive to ground	<u>3.5×10^{11}</u>	<u>1226 pf</u>	<u>CMH-3</u>
(3) Negative to ground	<u>4×10^{11}</u>	<u>1100 pf</u>	<u>CMH-3</u>

e. Micro-Micro Ammeter replacement

- (1) Remove Micro-Micro Ammeter from console and replace with spare
- (2) Reconnection of cables verified

CMH-3

Jan

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

f. (Linear Cont.) Record after step e. (1) has been performed

(1) Keithley	Meter	Recorder	Initial
6.66×10^{-5}	<u>6.6</u>	<u>100</u>	<u>CMB</u>
2.0×10^{-5}	<u>2.0</u>	<u>100</u>	<u>CMB</u>
6.66×10^{-6}	<u>6.8</u>	<u>101</u>	<u>CMB</u>
2.0×10^{-6}	<u>2.0</u>	<u>100</u>	<u>CMB</u>
6.66×10^{-7}	<u>6.8</u>	<u>101</u>	<u>CMB</u>
2.0×10^{-7}	<u>2.0</u>	<u>101</u>	<u>CMB</u>
6.66×10^{-8}	<u>6.65</u>	<u>100</u>	<u>CMB</u>
2.0×10^{-8}	<u>1.99</u>	<u>100</u>	<u>CMB</u>
6.66×10^{-9}	<u>6.6</u>	<u>100</u>	<u>CMB</u>
2.0×10^{-9}	<u>2.0</u>	<u>100</u>	<u>CMB</u>
6.66×10^{-10}	<u>6.5</u>	<u>99</u>	<u>CMB</u>
2.0×10^{-10}	<u>1.9</u>	<u>99</u>	<u>CMB</u>

g. Reconnect all cables
Reconnection of cables verified

CMB
JW

Note: From 10^{-5} to 10^{-9} , the overall accuracy should be better than 2% of full scale. From 3×10^{-9} to 3×10^{-10} the overall accuracy should be better than 4%.

3. Log Count Rate Channel

Initial

a. Log Count Rate Recorder

Date JAN 1 1985

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube type

NONE

CMB
CMB

b. Fission Preamp

Date JAN 1 1985

(1) Cleaned chassis and inspected

CMB

- b. Fission Preamp (cont.)
 (2) Additional Comments

c. Log Count Rate Channel

Date JAN 11 1985

(1) Pulse Generator*	Meter	Recorder	Initial
10	<u>10</u>	<u>10²</u>	<u>CMB</u>
100	<u>80</u>	<u>80</u>	<u>CMB</u>
1,000	<u>1030</u>	<u>10³</u>	<u>CMB</u>
10,000	<u>10100</u>	<u>10⁴</u>	<u>CMB</u>

Reconnection of cables verified

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

Jan

4. Safety Channels

a. Safety Preamp

Date DEC 20 1984

- (1) Cleaned chassis
 (2) Tested all vacuum tubes

Replaced: tube # tube type

NONE

b. Neutron Detector #1

Resistance

JAN 10 1985

- (1) Signal to ground
 (2) Positive to ground
 (3) Additional Comments

6.8 X 10¹¹

2.5 X 10¹¹

CMB

CMB

c. Neutron Detector # 2

Resistance

JAN 10 1985

- (1) Signal to ground
 (2) Positive to ground
 (3) Additional Comments

7 X 10¹¹

2.5 X 10¹¹

CMB

CMB

4. Safety Channels (cont.)

Initial

d. Safety Amplifier

Date DEC 20 1984
DEC

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced: tube # tube typeNONE

_____CMB
CMB

e. Safety Amplifier Adjustments

CMB

f. Replace all cables to safety amplifier

Reconnection of cables verified

CMB
Jan

5. PAT 60 Controller

a. PAT 60

Date JAN 21 1985

(1) Cleaned chassis

(2) Tested all vacuum tubes

CMB
CMB

b. Check dial settings and record the following

(1) Approach
(2) Proportional Bond 70
(3) Rate Time 0.03
(4) Reset 6
(5) Gain (if applicable) 1.5CMB
CMB
CMB
CMB
CMB

6. Temperature Recorder

Date JAN 18 1985

a. Reading #	Thermometer	Recorder
1	80°F	81
2	80°F	81
3	80°F	80
1	¹²⁰ 140°F	120
2	¹²⁰ 140°F	120
3	¹²⁰ 140°F	120

CMB
CMB
CMB
CMB
CMB
CMBNote: All readings should be $\pm 1^\circ\text{F}$

6. Temperature Recorder (cont.)

Date JAN 21 1985

Initial

b. 135°F Interlock

Trip Point

135CMB

7. Regulated Power Supply

Date JAN 21 1985

a. Cleaned chassis

b. Additional comments

CMB

8. Conductivity Bridge

Date JAN 1 1985

a. Cleaned chassis

b. Additional comments

CMB

9. Relay Test

Date JAN 21 1985

a. Console relays tested and replaced as per SOP 815

b. Relays Replaced

NoneCMBCMB

10. Rod Indicator Calibration

Date JAN 1 - 1984

Actual Height

I.

II.

III.

Reg.

1"

1111

6"

6666

12"

12121212

18"

18181818

24"

24242424CMB

11. Fire Alarm Check

Date JAN 1 1985

Initial

- a. Cleaned system containers
- b. Changed batteries
- c. Checked pull stations
- d. Checked heat detectors
- e. Checked smoke detectors
- f. All indicator lamps operate

CMB
CMB
CMB
CMB
CMB
CMB

12. Security System Check

Date 1985

- a. Door Sensors
- b. Motion Detectors
- c. Duress Alarm
- d. Control Modules (at UMR Police office) Date 1985
 - (1) Power Supply
 - (2) Control Module

CMB
CMB
CMB
CMB
CMB

13. Public Address System

Date 1985

- (1) Cleaned chassis
- (2) Additional Comments

CMB

14. Area Radiation Monitor

Date JAN 18 1985

- (1) Cleaned chassis.
- (2) Additional Comments

CMB

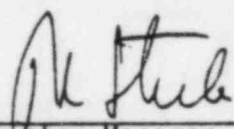
Calibration checked Sat.

Date 22 Jan 1985

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

Director

or



Reactor Manager

Semi Annual Check List

Date Commenced AUG 9 1984Date Completed AUG 27 1984Total Hours on Hour Meter 8843.25

1. Log N and Period Channel

Initial

a. Nog N Power Supply

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

V4	5651
V5	5651
V6	5651

CMB
CMB

b. Log N Recorder

Date AUG 9 1984

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

None	

CMB
CMB

c. Neutron Detector Check

Resistance (ohms)

Capacitance (pf)

(1) Signal to ground

 1.2×10^{12} 1.162×10^3 pf

CMB

(2) Positive to ground

 6.7×10^{12} 1.248×10^3 pf

CMB

(3) Negative to ground

 5×10^{12} 1.226×10^3 pf

CMB

d. Log N Calibration

Date AUG 9 1984

Initial

1. Meter

Recorder

Keithley

100

100 5×10^{-5} CMB

10

10 5×10^{-6} CMB

1

1 4×10^{-7} CMB

0.1

0.1 5×10^{-8} CMB

.01

0.01 6.4×10^{-9} CMB

.001

0.001 5×10^{-10} CMB

.0001

0.0002 5×10^{-11} CMB

Reconnection of Cables Verified

MS

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

e. Period Recorder

Date AUG 10 1984

(1) Cleaned chassis

CMB

(2) Tested all vacuum tubes

CMB

Replaced:

tube #

tube type

None

2. Linear Power Channel

a. Linear Power Supply

Date AUG 9 1984

(1) Cleaned chassis

CMB

(2) Tested all vacuum tubes

CMB

Replaced:

tube #

tube type

V105651V75651

B-12

b. Linear Recorder

Date AUG 1984

- (1) Cleaned chassis
 (2) Tested all vacuum tubes

CUMB
CUMB

Replaced: tube # tube type

NONE

c. Micro-Micro Ammeter (Spare)

Date AUG 1 1984

- (1) Cleaned chassis
 (2) Tested all vacuum tubes

CUMB
CUMB

Replaced: tube # tube type

NONE

d. Linear Neutron Detector Check

	Resistance (ohms)	Capacitance (pf)	
(1) Signal to ground	<u>1×10^9</u>	<u>1.262×10^3 pf</u>	<u>CUMB</u>
(2) Positive to ground	<u>1×10^9</u>	<u>1.257×10^3 pf</u>	<u>CUMB</u>
(3) Negative to ground	<u>1×10^9</u>	<u>580 pf</u>	<u>CUMB</u>

e. Micro-Micro Ammeter replacement

- (1) Remove Micro-Micro Ammeter from console and replace with spare
 (2) Reconnection of cables verified

* CUMB
~~CUMB~~

* Unit was Replaced on Jun 14, 1984

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

f. (Linear Cont.) Record after step e. (1) has been performed

(1) Keithley	Meter	Recorder	Initial
6.66×10^{-5}	6.60	100	CMB
2.0×10^{-5}	1.98	100	CMB
6.66×10^{-6}	6.60	101	CMB
2.0×10^{-6}	1.99	101	CMB
6.66×10^{-7}	6.66	102	CMB
2.0×10^{-7}	2.00	102	CMB
6.66×10^{-8}	6.60	100	CMB
2.0×10^{-8}	2.00	101	CMB
6.66×10^{-9}	6.62	101	CMB
2.0×10^{-9}	2.00	101	CMB
6.66×10^{-10}	6.60	98	CMB
2.0×10^{-10}	1.95	98	CMB

g. Reconnect all cables
Reconnection of cables verified

CMB
JAS

Note: From 10^{-5} to 10^{-8} , the overall accuracy should be better than 2% of full scale. From 3×10^{-9} to 3×10^{-10} the overall accuracy should be better than 4%.

3. Log Count Rate Channel

Initial

a. Log Count Rate Recorder

Date AUG 2 1984

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

None

CMB
CMB

b. Fission Preamp

Date AUG 2 1984

(1) Cleaned chassis and inspected

CMB

B-14

- b. Fission Preamp (cont.)
 (2) Additional Comments

c. Log Count Rate Channel

Date _____

(1) <u>Pulse Generator*</u>	<u>Meter</u>	<u>Recorder</u>	<u>Initial</u>
10	<u>10</u>	<u>10</u>	<u>10/10/83</u>
100	<u>100</u>	<u>100</u>	<u>10/10/83</u>
1,000	<u>1000</u>	<u>1000</u>	<u>10/10/83</u>
10,000	<u>10000</u>	<u>10000</u>	<u>10/10/83</u>

Reconnection of cables verified

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

4. Safety Channels

a. Safety Preamp

Date AUG 11, 1984

- (1) Cleaned chassis
 (2) Tested all vacuum tubes

Replaced: tube # tube type

<u>none</u>	<u></u>
<u></u>	<u></u>
<u></u>	<u></u>
<u></u>	<u></u>
<u></u>	<u></u>

b. Neutron Detector #1

Resistance

- (1) Signal to ground
 (2) Positive to ground
 (3) Additional Comments

<u>9.5×10^{12}</u>
<u>1.2×10^{10}</u>

10/10/83
10/10/83

c. Neutron Detector # 2

Resistance

- (1) Signal to ground
 (2) Positive to ground
 (3) Additional Comments

<u>9×10^{12}</u>
<u>1.2×10^{10}</u>

10/10/83
10/10/83

4. Safety Channels (cont.)

Initial

d. Safety Amplifier

Date AUG 9

- 1) Cleaned chassis
- (2) Tested all vacuum tubes

Replaced:	<u>tube #</u>	<u>tube type</u>
	<u>None</u>	<u> </u>
	<u> </u>	<u> </u>
	<u> </u>	<u> </u>
	<u> </u>	<u> </u>
	<u> </u>	<u> </u>

COMP
COMP

e. Safety Amplifier Adjustments

COMP

- f. Replace all cables to safety amplifier
- Reconnection of cables verified

COMP
PLS

5. PAT 60 Controller

a. PAT 60

Date

- (1) Cleaned chassis
- (2) Tested all vacuum tubes

COMP
COMP

b. Check dial settings and record the following

- (1) Approach 6.1
- (2) Proportional Band 70
- (3) Rate Time 0.03
- (4) Reset 6
- (5) Gain (if applicable) 1.5

COMP
COMP
COMP
COMP
COMP

6. Temperature Recorder

Date AUG . 1984

a. Reading #	Thermometer	Recorder
1	80°F	<u>80</u>
2	80°F	<u>80</u>
3	80°F	<u>80</u>
1	140°F	<u>140</u>
2	140°F	<u>139</u>
3	140°F	<u>139</u>

COMP
COMP
COMP
COMP
COMP
COMP

Note: All readings should be $\pm 1^\circ\text{F}$

6. Temperature Recorder (cont.)

Date AUG 1984

Initial

b. 135°F Interlock

Trip Point
135CMB

7. Regulated Power Supply

Date AUG 1984

a. Cleaned chassis

b. Additional comments

CMB

8. Conductivity Bridge

Date AUG 1984

a. Cleaned chassis

b. Additional comments

CMB

9. Relay Test

Date AUG 1984

a. Console relays tested and replaced as per SOP 815

b. Relays Replaced NONE

_____CMB
CMB

10. Rod Indicator Calibration

Date Aug 1984

Actual Height	I.	II.	III.	Reg.
1"	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>
6"	<u>6</u>	<u>6</u>	<u>6</u>	<u>6</u>
12"	<u>12</u>	<u>12</u>	<u>12</u>	<u>12</u>
18"	<u>18</u>	<u>18</u>	<u>18</u>	<u>18</u>
24"	<u>24</u>	<u>24</u>	<u>24</u>	<u>24</u>

CMB

11. Fire Alarm Check

Date AUG 1 1984

Initial

- a. Cleaned system containers
- b. Changed batteries
- c. Checked pull stations
- d. Checked heat detectors
- e. Checked smoke detectors
- f. All indicator lamps operate

CMB
CMB
CMB
CMB
CMB
CMB

12. Security System Check

Date AUG 1 1984

- a. Door Sensors
- b. Motion Detectors
- c. Duress Alarm
- d. Control Modules (at UMR Police office) Date AUG 1 1984
 - (1) Power Supply
 - (2) Control Module

CMB
CMB
CMB
CMB
CMB

13. Public Address System

Date 1 1 1984

- (1) Cleaned chassis
- (2) Additional Comments

CMB

14. Area Radiation Monitor

Date AUG 1 1984

- (1) Cleaned chassis
- (2) Additional Comments

CMB

Date 27 August 84

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

Director

or

Al Steube
Reactor Manager

APPENDIX C
Revised SOP's

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 101

REVISED: 09-04-84

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 ($\Delta k > 0.2\%$) 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 0.5% 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

Rev.

WRITTEN BY: Milan Straka

APPROVED BY:

A. Z. Balon

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

STANDARD OPERATING PROCEDURES

S.O.P.: 101

REVISED: 9-4-84

PAGE 2 OF 3

TITLE: General Operational Procedures

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

WRITTEN BY: Milan Straka

APPROVED BY:

UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
S.O.P.: 101	REVISED: 09-04-84	PAGE 3 OF 3
TITLE: General Operational Procedures		
<p>for insertion and removal. This log entry shall include date and time.</p> <p>16. A temporary change to the SOP's may be made with the consent of two licensed Operators, one being a licensed Senior Operator. This change shall be submitted in writing within ten working days to the Reactor Director for Approval or Revision.</p> <p>17. If at any time during reactor startup or operation the Reactor Operator notices any abnormal behavior of the instrumentation (meters and recorders), he/she should immediately bring it to the attention of the Senior Operator on Duty. If there is any doubt as to whether the equipment is functioning properly, the reactor shall be shut down. Then the cause should be determined and corrective action taken.</p>		
<p>WRITTEN BY: Milan Straka <i>M. Straka</i> APPROVED BY: <i>A.E. Bolon</i> Albert Bolon</p>		

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UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
S.O.P.: 103	REVISED: 9-4-84	PAGE 1 OF 5
TITLE: Reactor Start Up Procedure		
<p>A. <u>Purpose</u> To ensure 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.</p> <p>B. <u>Precautions, Prerequisites, Limitations</u></p> <ol style="list-style-type: none"> 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 (in 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: Milan Straka <i>M. Straka</i>		APPROVED BY: <i>A. Z. Bolon</i> Albert Bolon

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UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
S.O.P.: 103	REVISED: 9-4-84	PAGE 2 OF 5
TITLE : Reactor Start Up Procedure		
<p>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.</p> <p>8. Building exhaust 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.</p> <p>9. The safety channel meters should begin to give a definite positive indication when the reactor power is at about 5 kW.</p> <p>10. If the desired reactor power is greater than 20 W, the reactor shall first be taken to 20 W, (or some similar low power as specified by the Senior Operator on Duty), put in automatic control, and the hourly logs taken. The Reactor Operator shall check that all instrumentation is functioning properly.</p> <p>11. If the desired reactor power is greater than 20 kW, the reactor shall be taken to 20 kW (or some similar intermediate power between 6 kW and 60 KW as specified by the Senior Operator on Duty), put in automatic control, and the hourly logs taken. The Reactor Operator shall check that all instrumentation is functioning properly, especially the safety (power) channels.</p> <p>C. <u>Procedures</u></p> <p>1. Clean core, shim rods at 6 inches and neutron source installed.</p> <p>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</p>		
WRITTEN BY: Milan Straka <i>M. Straka</i>		APPROVED BY: <i>Albert E. Bolon</i> Albert E. Bolon

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UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
S.O.P.: 103	REVISED: 9-4-84	PAGE 3 OF 5
TITLE: Reactor Start Up Procedure		
<p>between 12.0 and 12.5 inches.</p> <ol style="list-style-type: none"> 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. (The count rate will have approximately doubled if all the shim/safety rods have been withdrawn.) 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 (5) 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 		
WRITTEN BY: Milan Straka		APPROVED BY: Albert Bolon

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STANDARD OPERATING PROCEDURES		
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TITLE: Reactor Start Up Procedure		
<p>infinity (∞) and there will be an increasing power level indication on the log N recorder (vertical line). Typically the period and log N meters and recorders will begin to provide positive indications when the log count rate recorder is at approximately 3×10^3.</p> <p>9. When the log count rate recorder reaches full scale (10^4) withdraw the fission chamber until a 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.</p> <p>10. Establish a reactor period as requested by the Senior Operator on Duty, (or approximately 50 seconds) and continue the reactor power increase to the desired power level on the linear range selector.</p> <p>11. When the linear power is on the 6 watt scale ask someone to withdraw the startup source.</p> <p>12.* 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.</p> <p>13.* 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</p> <p>*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.</p>		
WRITTEN BY: Milan Straka	<i>M Straka</i>	APPROVED BY: <i>Albert Bolon</i> Albert Bolon

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UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR		
STANDARD OPERATING PROCEDURES		
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TITLE: Reactor Start Up Procedure		
<p>auto permit light) in the auto position. When the "Auto" light comes on release the switch (return to neutral).</p> <p>14. Ensure that the regulating rod momentarily inserts (white light) and is satisfactorily controlling reactor power at the intended setpoint (red pointer on linear recorder).</p> <p>15. Reset the Manual Operations Annunciator.</p> <p>16. Record the time from the console clock in the Hourly Log (time at power).</p> <p>17. Inform personnel of the reactor power level on the building public address system. "The reactor is at a power level of _____ watts or kilowatts".</p> <p>18. Position the fission chamber to achieve a log count rate recorder indication of 10^2 (mid scale).</p> <p>19. Complete Hourly Logs in accordance with SOP 104.</p> <p>2. High-residual activity (hot) core, shim rods at 6 inches and neutron source installed.</p> <p>1. Perform actual startup steps similar to those of C.1 for a clean core, except pause slightly longer between rod withdrawals and be prepared for the reactor to behave differently than usual and for the critical rod height to be different than for a cold, clean core.</p>		
WRITTEN BY: Milan Straka <i>M. Straka</i>		APPROVED BY: <i>Albert Bolon</i> Albert Bolon

Rev.

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***
 SOP: 800 Title: SEMI ANNUAL CHECKLIST
 Revised: March 26, 1985

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Semi Annual Check List

Date Commenced _____

Date Completed _____

Total Hours on Hour Meter _____

1. Log N and Period Channel

Initial

a. Log N Power Supply

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced: tube # tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

b. Log N Recorder

Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced: tube # tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

c. Neutron Detector Check Resistance (ohms) Capacitance (pf)

(1) Signal to ground	_____	_____	_____
(2) Positive to ground	_____	_____	_____
(3) Negative to ground	_____	_____	_____

Carl Barton
 Written By: Carl Barton

Albert Bolton
 Approved By: Albert Bolton

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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d. Log N Calibration

1. Meter	Recorder	Date <u>Keithley</u>	Initial
100	_____	_____	_____
10	_____	_____	_____
1	_____	_____	_____
0.1	_____	_____	_____
.01	_____	_____	_____
.001	_____	_____	_____
.0001	_____	_____	_____

Reconnection of Cables Verified _____

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

e. Period Recorder

Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced: tube # tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

2. Linear Power Channel

a. Linear Power Supply

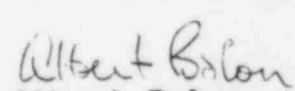
Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced: tube # tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Written By:  Carl BartonApproved By:  Albert Balon

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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b. Linear Recorder

Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced:

tube #tube type_____

c. Micro-Micro Ammeter (Spare)

Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced:

tube #tube type_____

d. Linear Neutron Detector Check

Resistance (ohms) Capacitance (pf)

(1) Signal to ground _____

(2) Positive to ground _____

(3) Negative to ground _____

e. Micro-Micro Ammeter replacement

(1) Remove Micro-Micro Ammeter from console and replace
with spare _____

(2) Reconnection of cables verified _____

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


 Written By: Carl Barton


 Approved By: Albert Bolon

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f. (Linear Cont.) Record after step e. (1) has been performed

(1) Keithley	Meter	Recorder	Initial
6.66×10^{-5}	_____	_____	_____
2.0×10^{-5}	_____	_____	_____
6.66×10^{-6}	_____	_____	_____
2.0×10^{-6}	_____	_____	_____
6.66×10^{-7}	_____	_____	_____
2.0×10^{-7}	_____	_____	_____
6.66×10^{-8}	_____	_____	_____
2.0×10^{-8}	_____	_____	_____
6.66×10^{-9}	_____	_____	_____
2.0×10^{-9}	_____	_____	_____
6.66×10^{-10}	_____	_____	_____
2.0×10^{-10}	_____	_____	_____

g. Reconnect all cables

Reconnection of cables verified

Note: From 10^{-5} to 10^{-8} , the overall accuracy should be better than 2% of full scale. From 3×10^{-9} to 3×10^{-10} the overall accuracy should be better than 4%.

3. Log Count Rate Channel

Initial

a. Log Count Rate Recorder

Date _____

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #

tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

b. Fission Preamp

Date _____

(1) Cleaned chassis and inspected

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- b. Fission Preamp (cont.)
 (2) Additional Comments

c. Log Count Rate Channel Date _____

(1) Pulse Generator*	Meter	Recorder	Initial
10	_____	_____	_____
100	_____	_____	_____
1,000	_____	_____	_____
10,000	_____	_____	_____

Reconnection of cables verified _____

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

4. Safety Channels

a. Safety Preamp Date _____

(1) Cleaned chassis _____

(2) Tested all vacuum tubes _____

Replaced: tube # tube type

_____	_____
_____	_____
_____	_____
_____	_____

b. Neutron Detector #1 Resistance

(1) Signal to ground	_____	_____
(2) Positive to ground	_____	_____
(3) Additional Comments	_____	_____

c. Neutron Detector # 2 Resistance

(1) Signal to ground	_____	_____
(2) Positive to ground	_____	_____
(3) Additional Comments	_____	_____

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Approved By:  Albert Bolon

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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4. Safety Channels (cont.)

Initial

d. Safety Amplifier

Date _____

(1) Cleaned chassis

(2) Tested all vacuum tubes

Replaced:

tube #tube type

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

e. Safety Amplifier Adjustments

f. Replace all cables to safety amplifier

Reconnection of cables verified

5. PAT 60 Controller

a. PAT 60

Date _____

(1) Cleaned chassis

(2) Tested all vacuum tubes

b. Check dial settings and record the following

(1) Approach _____

(2) Proportional Band _____

(3) Rate Time _____

(4) Reset _____

(5) Gain (if applicable) _____

6. Temperature Recorder

Date _____

a. 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 $\pm 1^\circ\text{F}$ Written By: *Carl Barton*
Carl BartonApproved By: *Albert Bolon*
Albert Bolon

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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6. Temperature Recorder (cont.) Date _____ Initial _____

b. 135°F Interlock Trip Point _____

7. Regulated Power Supply Date _____

a. Cleaned chassis _____

b. Additional comments _____

8. Conductivity Bridge Date _____

a. Cleaned chassis _____

b. Additional comments _____

9. Relay Test Date _____

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

b. Relays Replaced _____

10. Rod Indicator Calibration Date _____

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

Written By:  Carl BartonApproved By:  Albert Bolan

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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11. Fire Alarm Check

Date _____

Initial _____

- a. Cleaned system containers _____
- b. Changed batteries _____
- c. Checked pull stations _____
- d. Checked heat detectors _____
- e. Checked smoke detectors _____
- f. All indicator lamps operate _____

12. Security System Check

Date _____

- a. Door Sensors _____
- b. Motion Detectors _____
- c. Duress Alarm _____
- d. Control Modules (at UMR Police office) Date _____
 - (1) Power Supply _____
 - (2) Control Module _____

13. Public Address System

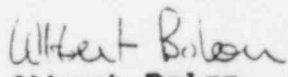
Date _____

- (1) Cleaned chassis _____
- (2) Additional Comments _____

14. Area Radiation Monitor

Date _____

- (1) Cleaned chassis _____
- (2) Additional Comments _____

Written By:  Carl BartonApproved By:  Albert Bolon

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

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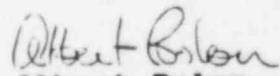
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Date _____

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

Written By: 
Carl Barton

Approved By: 
Albert Balon

The following Standard Operating Procedures were slightly changed in the accounting period. Thus the entire pages were not included in this report because the changes were not considered to be substantive.

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104	1,2,3,4,5,6	3-28-85
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501	1,2,3,4,5,6,7	9-4-84
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704	1,2	9-4-84
800	1,2,3,4,5,6,7,8,9	3-26-85
816	1,2,3,4	2-7-85

APPENDIX D

Changes Authorized by 10 CFR 50.59

1. Change in the Core Access Element Drawing

During the review for an experiment using the core access element it was discovered that the element's graphite filling had been omitted in the sketch and the element description given on pages 3-17 and 3-18 in the UMRR Safety Analysis Report (SAR). However, the proper reactivity upon the accidental flooding based on the data provided by Curtiss & Wright was taken into account in the accident analysis performed in Section 9.2 of SAR. Subsequent evaluations and calculations performed in conjunction with the planned experiment confirmed the results given in SAR. For the purpose of determining the reactivity worth of the core access element a subcritical experiment was performed on 3 April 1985. Experimental data have shown that its reactivity worth at the core periphery is about 0.02% $\Delta k/k$. A revised sketch of the core access element is shown on the next page.

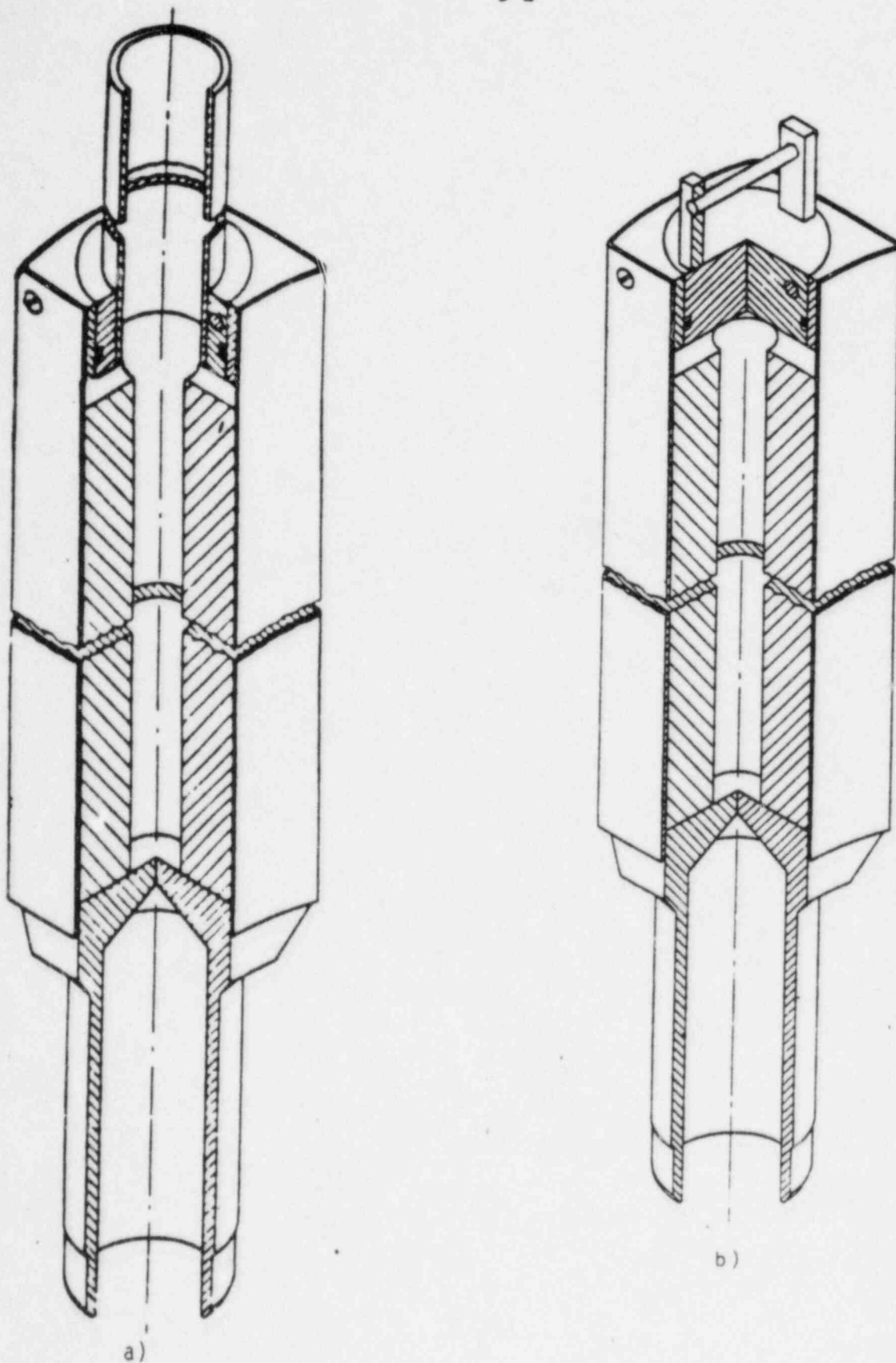


Figure 15. (a) Core access element
(b) Isotope production element.

Rev. 4-10-85

2. Change in the Preparation of the Annual Examination for Licensed Operators

The UMRR Operator Requalification Program specifies on page 4 (third paragraph) that "The exam with answer sheet will then be reviewed by the Head of the Safety Committee for his approval." This has been changed in that this statement now reads as follows "The exam with answer sheet will then be reviewed by a faculty member from the Nuclear Engineering Department of the University of Missouri-Rolla or other knowledgeable person." The revised page of the Operator Requalification Program is included on the next page.

a. Lectures or review seminars to present or discuss in a preplanned manner the information relative to each of the areas listed above. Personnel assigned to prepare questions or sections of the annual exam may be exempt for those specific questions or sections.

b. Worksheet questions and problems which the operator can answer in his spare time.

The training coordinator will be assigned responsibility to prepare the ten sections of the annual exam. The exam with answer sheet will then be reviewed by a faculty member from the Nuclear Engineering Department of the University of Missouri-Rolla or other knowledgeable person. The training coordinator will assign to various staff members topics for which they must write, in outline form, and present to the rest of the staff in a formal lecture. The lectures will be on topics, that will comply with 10 CFR 55 Appendix A. The evaluation of each operator will be facilitated by completing an examination record form as shown in Appendix A to this document.

1 Rev.
4-15-85

An operator will be considered to be deficient in any area of the exam if he scores a grade of less than 80% in that area. If the average grade for an operator in all sections is less than 80%, the operator shall be relieved of all licensed activities until he has been retrained and satisfactorily passes re-examination with an average grade greater than 80%.

After all of the examinations have been graded, the Training Coordinator will prepare the retraining schedule for those operators who were deficient in any area. The TC will use Retraining Schedule sheets as shown in Appendix A to facilitate the scheduling.



UNIVERSITY OF MISSOURI-ROLLA



Nuclear Reactor Facility

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

April 29, 1985

Mr. Cecil O. Thomas
Chief, Standardization & Special
Projects Branch
Division of Licensing
NRC
Washington, D.C. 20555
Mail Stop 228

Dear Mr. Thomas:

Attached is a complimentary copy of the 1984-1985 Progress Report for the
University of Missouri - Rolla Nuclear Reactor Facility.

Sincerely,

A handwritten signature in cursive script, appearing to read 'M. Straka'.

Milan Straka
Reactor Manager

sr

Enclosure

A020
11