UNIVERSITY OF MISSOURI-ROLLA

Nuclear Reactor Facility

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

April 30, 1991

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

Dear Sir:

Please find enclosed the Annual Progress Report 1990-91 for the University of Missouri-Rolla Reactor Facility (License R-79). This report is being filed under the reporting requirements of our Technical Specifications. A copy of this report is also being sent to our Project Manager and Regional Administrator.

Sincerely,

David W. Freeman
Reactor Manager

DWF/lp

Enclosure

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

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Progress Report
1990-91
University of Missouri-Rolla
Nuclear Reactor Facility

UNIVERSITY OF MISSOURI - ROLLA

REACTOR

PROGRESS REPORT

FOR THE

UNIVERSITY OF MISSOURI-ROLLA

NUCLEAR REACTOR FACILITY

APRIL 1, 1990 TO MARCH 31, 1991

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

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

SUMMARY

During the 1990-91 reporting period the University of Missouri-Rolla Reactor (UMRR) was in use for 387 hours. The major part of this time, 71%, was used for class instruction and training purposes. About 15% of the reactor time was used for research and irradiation service and 6% was needed for maintenance runs.

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

There were 25 undergraduate and graduate students enrolled for course work at the reactor, not including the NE 105 students and the UMC graduate students. This committed the facility to 90 student credit-hours of classes. The reactor was visited by about 2641 visitors during the past year. There were 500 participants in the Reactor Sharing Program this year involved in various reactor projects. The facility is reimbursed for this program under a grant awarded by the U.S. Department of Energy.

The reactor produced about 11.6 MW hours of energy using approximately 0.5 gram of uranium. A total of 210 samples have been irradiated at the reactor with most of them being analyzed in the Reactor Counting Laboratory.

A one-week training program for reactor operator trainees of a Midwest utility was conducted during this reporting period. The reimbursement helped to defray facility costs and also helped to improve research and instructional capabilities.

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1.0 Introduction

This progress report covers activities at the University of Missouri-Rolla Reactor (UMRR) Facility for the period April 1, 1990 to March 31, 1991. It is prepared in accordance with the requirements of 10 CFR Part 50.71 and Technical Specifications 6.6.1 issued under License R-79.

The reactor 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, colleges, and high schools have made use of the facility during this reporting period. The facility is also made available for the purpose of training reactor personnel of the nuclear industry and electric utilities. Trace element analysis using neutron activation is also provided at the facility.

1.1 Background Information

The University of Missouri-Rolla Reactor (UMRR) Facility was constructed in 1960-1961 and attained criticality on December 9th, 1961. The UMRR was the first operating nuclear reactor in the state of Missouri. The reactor design is based on the Bulk Shielding Reactor at Oak Ridge National Laboratory. The initial licensed power was 10 kW which was subsequently upgraded to 200 kW in 1966.

The reactor is a pool-type reactor cooled by natural

convection flow. The fuel is MTR plate-type fuel. The standard fuel element consists of ten curved plates fueled with high-enriched uranium.

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

1.2 Facility Status

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

Major progress has been made in the LEU conversion process. NRC concerns regarding our proposed LEU Safety Analysis Report and Technical Specifications have been addressed. On March 5, 1991 NRC issued the order modifying our license to convert to LEU, effective the date of receipt of the LEU fuel.

Conversations with the fuel suppliers indicate that we may receive "dummy" (unfueled) elements for testing this

summer. We plan to extensively test the dummies to assure dimensional compatibility with our control rods and drives, gridplate, and experimental facilities.

We have received preliminary word that the new LEU fuel may be available in the Summer of 1991. We plan to prepare a detailed core loading and start-up testing plan for the new fuel.

We received a grant from DOE to aid in purchasing new nuclear instrumentation for the UMRR console. The cost of the upgrade is being shared directly from reactor funds. We plan to use these funds to upgrade our Start-up, Linear, and Intermediate Channel instrumentation.

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.

2.0 Reactor Staff and Personnel

2.1 Reactor Staff

Name	Title
Albert E. Bolon	Director
David Freeman[1)]	Reactor Manager
Carl Barton	Senior Electronic Technician
Juls Williams	Lab Mechanic
Francis Jones	Reactor Maintenance Engineer
Linda Pierce	Senior Secretary

2.2 Licensed Operators

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

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1) Effective May 1, 1990

2) Effective February 21, 1991

2.3 Radiation Safety Committee

The Radiation Safety Committee is required to meet quarterly. The committee met on 6/5/90, 9/5/90, 12/7/90 and 2/20/91 during the reporting period. The committee members are listed below:

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

2.4 Health Physics

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

Name	Title
Dr. Nick Tsoulfanidis	Radiation Safety Officer
Mr. Ray Bono	Director, Environmental Health and Risk Management
Miss Kathy Stone[2)]	Student Assistant (HP)
Mr. Mark Sautman[3)]	Student Assistant (HP)
Mr. Charles Hooper[4)]	Student Assistant (HP)
Miss Danika Jackson[1)]	Student Assistant (HP)
Mr. Cary Lieurance	Student Assistant (HP)

1) terminated effective May, 1990

2) terminated effective August, 1990

3) employed effective August, 1990

4) employed effective June, 1990

3.0 Improvements

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

1) An emergency shower and eyewash station have been installed adjacent to the demineralizer system on the intermediate level of the basement.
2) A fiber-optics cable has been installed linking the UMRR computers to the University network, allowing access to several mainframe and workstation systems.
3) Several codes have been made operational on the facilities AT&T 6386 Workstation including 2DB-UM, LEOPARD, ONETRAN, ORIGEN2, QADCG, and DSNP.
4) A database management code has been developed with DBASE-III to track reactor usage and burnup by course number, run type, and experimental facility. This code is being used to generate data for the annual report.
5) An IBM PS-2 and a new copier have been purchased to support administrative wordprocessing and recordkeeping.
6) The beamport facility has been reopened for use and preliminary beam characterization studies and radiographic imaging have been accomplished.

7) Totalizers have been installed on the basement sump to track the water volume pumped from the sump to the sewer system.

8) A security mirror has been installed in the front office to provide a better view of the entrance door area.

9) New nuclear instrumentation to replace our Start-up, Linear, and Intermediate Channels will soon be purchased.

10) The floors in the Reactor bay, stairways, intermediate basement, and ground floor have all been painted in an effort to maintain high standards of housekeeping.

4.0 Reactor Operations

Core designation 67 has been used throughout this reporting period. The "W" mode core (completely water reflected) was used for normal reactor operations. The "T" mode (with the core positioned near the graphite thermal column) is used for various experiments including beam port and thermal column experiments. The excess reactivity was measured for the 67 W core configuration in cold, clean conditions. In day-to-day operation the excess reactivity is quite often lower due to higher pool temperatures.

Information about the reactor operation during this reporting period is presented in Tables 1 through 8.

Table 1. UMRR Core Configuration and Rack Storage Form

DATE 31 March, 1990 LOADING NUMBER 67T or 67W*

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

RACK STORAGE FACILITY

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

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

BRIDGE SIDE UMRR CORE STATUS

KEY TO PREFIXES

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

Other BRT - Bare Rabbit Tube
CRT - Cadmium Rabbit Tube

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

Table 2. Facility Use Other Than The Reactor

Facility	Hours
Bare Rabbit Tube	24
Beam Port	2
Thermal Column	1
Total	27

Table 3. Reactor Utilization

1. Reactor use	387 hr
a. Research and irradiation runs	58 hr
b. Instruction runs	218 hr
c. Maintenance runs	25 hr
d. Training	58 hr
2. Time at power	180 hr
3. Energy generated	11584 kw-hr
4. Total number of samples	210
5. Sample hours	32 hr
6. U-235 burned	0.5 g
7. U-235 burned and converted	0.6 g

Table 4. Rundowns

Date	Cause and Corrective Action
04/11/90	120% Demand - Range Switch button on Linear popped out while switching scales. Trainee given additional instructions.
04/11/90	120% Demand - Range switch button on Linear popped out. No corrective action necessary.
04/11/90	120% Demand - Cause and corrective action same as above.
04/25/90	120% Demand - Cause and corrective action same as above.
05/31/90	120% Demand - Operator down scaled on linear instead of up scale. Cautioned and instructed trainee about changing scales.
09/13/90	120% Demand - Button on Linear popped out. No corrective action necessary.
09/25/90	120% Full Power - Set point on Log N recorder set too low. Readjusted set point.
09/26/90	120% Demand - Range switch on picoammeter popped out. No corrective action necessary.
10/24/90	<15 sec Period - Happened while moving Void Tube during experiment. Reactor was at 18" (subcritical). Experimenter cautioned and instructed on moving the Void Tube.
10/31/90	High Radiation - Slightly elevated radiation levels at demineralizer caused by extended high power run. No corrective action required.
11/08/90	120% Demand - Operator pushed button on Linear. Operator cautioned and instructed on changing scales.
11/27/90	High Radiation - Slightly elevated radiation levels at demineralizer caused by extended high power run. No corrective action required.
01/23/91	120% Demand - Range Switch on Linear popped out. No corrective action necessary.

Rundowns (cont.

02/19/91	120% Demand - Range Switch on Linear popped out. Student given additional instruction.
03/27/91	120% Demand - Range Switch on Linear popped out while changing scales. No corrective action necessary.

Table 5. Scrams

Date	Cause
04/09/90	Manual Scram - Training.
04/17/90	Manual Scram - Intentional for experiment.
04/17/90	Manual Scram - Intentional for experiment.
04/20/90	Manual Scram - Intentional for experiment.
04/20/90	Manual Scram - Intentional for experiment.
04/23/90	Manual Scram - Intentional for experiment.
04/25/90	Manual Scram - Intentional for experiment.
04/26/90	Manual Scram - Intentional for experiment.
04/26/90	Manual Scram - Intentional for experiment.
05/31/90	Manual Scram - Training.
12/7/90	150% Full Power Scram - Reactor was at 52% of 2 W scale. Appeared to be spurious trip. System checked and returned to service.
01/23/91	Manual Scram - Training.
02/14/91	150% Full Power Scram - Occurred at reactor power of less than 200 kW. Scram thought to be spurious. Reactor restarted.
02/14/91	150% Full Power Scram - Occurred at reactor power of less than 200 kW. Scram Setpoint was inadvertently set too low during maintenance. Scram Setpoint reset.

Table 6. **Maintenance**

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

Date: 4/27/90
Problem: Rod 1 dropping.
Corrective Action: Removed Magnet No. 1 and repaired.

Date: 4/28/90
Problem: Continued from 4/27/90.
Corrective Action: Replaced Magnet No. 1. Completed Rod Drop Time Test.

Date: 4/30/90
Problem: "Reactor On" Light in Foyer not on when Reactor is operating.
Corrective Action: Replaced both bulbs in "Reactor On" Light.

Date: 5/3/90
Problem: Start-up Channel not indicating an increase in count rate while pulling rods.
Corrective Action: Reactor shutdown. Checked all connections on Start-up Channel. System check good. Reactor started up with no other problems indicated.

Date: 5/27/90
Problem: N/A
Corrective Action: Semi-Annuals started.

Date: 5/29/90
Problem: Routine visual inspection of rods.
Corrective Action: Unloaded reactor core. Rods inspected.

Date: 5/30/90
Problem: Continued from 5/29/90.
Corrective Action: Reinstalled magnets and completed Rod Drop Times.

Date: 5/31/90
Problem: Continued from 5/29/90.
Corrective Action: Reloaded reactor core.

Date: 5/15/90
Problem: Cadmium Rabbit Tube removed from core to repair water leak.
Corrective Action: None - Rabbit hung in pool for decay.

Table 6. Maintenance (cont.)

Date: 7/31/90
Problem: Semi-Annual Power Calibration indicates Log N detector position needs adjustment.
Corrective Action: Adjusted Log N detector for proper power indication.

Date: 8/2/90
Problem: Vent Fan No. 1 previously removed for maintenance by Physical Facilities. (Bearings)
Corrective Action: Vent Fan No. 1 replaced after bearings were replaced by Physical Facilities.

Date: 8/13/90
Problem: Checking temperature recorders as part of scheduled maintenance.
Corrective Action: None required.

Date: 8/13/90
Problem: N/A
Corrective Action: Semi-Annuals completed.

Date: 8/13/90
Problem: Log N level meter sticking.
Corrective Action: Replaced meter.

Date: 8/16/90
Problem: Power difficult to read on new meter.
Corrective Action: Log N Amplifier adjusted for easier reading on new meter.

Date: 8/23/90
Problem: Water leak in Cadmium Rabbit Tube.
Corrective Action: Repaired and reinstalled Cadmium Rabbit Tube in core.

Date: 8/23/90
Problem: Safety Channel reading low.
Corrective Action: UICs adjusted for proper output.

Date: 8/31/90
Problem: Magnet Contact Light on No. 2 not operating.
Corrective Action: Replaced pin in connector. Reinstalled magnet and checked Rod Drop Times.

Date: 8/31/90
Problem: Removed Bare Rabbit Tube to extend connectors above water to preclude potential future leaks.
Corrective Action: Maintenance delayed.

Table 6. Maintenance (cont.)

Date: 9/4/90
Problem: Continued from 8/31/90.
Corrective Action: Repaired Bare Rabbit Tube reinstalled in core.

Date: 9/7/90
Problem: Water found in Cadmium Rabbit Tube.
Corrective Action: Removed, repaired and reinserted Bare Rabbit after maintenance.

Date: 9/19/90
Problem: Water found in Cadmium Rabbit Tube.
Corrective Action: Removed Cadmium Rabbit Tube from core.

Date: 9/20/90
Problem: Safety Channels not indicating proper power.
Corrective Action: Adjusted UICs for correct readings.

Date: 9/24/90
Problem: Water found in Cadmium Rabbit.
Corrective Action: Reinserted Cadmium Rabbit Tube after repair of lower swage lock.

Date: 10/10/90
Problem: No Magnet Contact Light on No. 1 Magnet.
Corrective Action: Repaired Contact Light and replaced Magnet No. 1.

Date: 10/16/90
Problem: Performing Rod Drop Time.
Corrective Action: Rod Drop Time Test completed.

Date: 10/17/90
Problem: Removed Magnet No. 3.
Corrective Action: Replaced No. 3 Magnet and performed Rod Drop Time test.

Date: 10/19/90
Problem: Removed Magnet No. 3.
Corrective Action: Replaced Magnet with spare. Performed Rod Drop Time test.

Date: 10/31/90
Problem: Power Chambers need position adjustment.
Corrective Action: Adjusted chambers for correct reading.

Table 6. **Maintenance (cont.)**

Date: 11/6/90
Problem: Copper wire experiment stuck in Fuel Element F-8 in Core Position D-3.
Corrective Action: Removed Fuel Element from Position D-3. Removed copper wire experiment and reinserted element.

Date: 11/12/90
Problem: Bridge RAM not showing proper indication.
Corrective Action: Removed Bridge RAM module for maintenance.

Date: 11/12/90
Problem: Demineralizer RAM not indicating correctly.
Corrective Action: Removed Demineralizer RAM module for maintenance.

Date: 11/20/90
Problem: Continued from 11/12/90.
Corrective Action: Repaired and reinstalled Bridge RAM module.

Date: 11/20/90
Problem: Continued from 11/12/90
Corrective Action: Repaired and reinstalled Demineralizer module.

Date: 11/20/90
Problem: N/A
Corrective Action: Recalibrated Bridge and Demineralizer modules.

Date: 12/14/90
Problem: N/A
Corrective Action: Semi-Annuals started.

Date: 12/20/90
Problem: N/A
Corrective Action: Semi-Annuals completed.

Date: 1/14/91
Problem: Semi-Annual Power Calibration
Corrective Action: Adjusted Linear Channel CIC for proper indication.

Date: 1/28/91
Problem: Routine rod drop time test.
Corrective Action: Completed rod drop time test.

Date: 2/21/91
Problem: Safety Channel indicated high.
Corrective Action: Safety Channel repaired.

Table 6. Maintenance (cont.)

Date: 2/22/91
Problem: Continuation from 2/21/91.
Corrective Action: Repaired Safety Channel and adjusted SCRAM point.

Date: 2/25/91
Problem: <5 Second Period.
Corrective Action: Re-Adjusted Trip Point to 7 seconds for extra margin of safety.

Date: 3/20/91
Problem: Basement experiment room RAM meter sticking.
Corrective Action: Removed meter, checked and reinstalled meter. Recalibrated RAM.

Table 7. Core Loading and Unloading

Date	
05/29/90	Unload (67W to subcrit) for control rod inspection.
05/31/90	Reload (subcrit to 67W) to return to previous configuration.
11/06/90	Removed Fuel Element F-8 to unload copper wire experiment.

Table 8. Core Technical Data

Average Therr al Flux	$1.6X10^{12}$ n/cm^2-sec at 200 kW
Maximum Thermal Flux	$2.8X10^{12}$ n/cm^2-sec at 200 kW
Average Epithermal Flux	$1.6X10^{11}$ n/cm^2-sec at 200 kW
Worth of Thermal Column	0.46% Δ k/k
Worth of Bean Port	not detectable

Rod Worths (in "T" mode):

Rod 1:	2.63% Δk/k	(4/16/79)
Rod 2:	2.65% Δk/k	(4/16/79)
Rod 3:	3.36% Δk/k	(4/16/79)
Reg Rod:	0.34% Δk/k	(9/14/89)

Excess Reactivity (in "W" mode): 0.6% Δk/k

Shutdown Margin (in "W" mode)*: 4.7% Δk/k

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*) Rod 3 and Reg Rod not taken into account.

5.0 Public Relations

The reactor staff continues to help educate the public about applications of nuclear science. Over 2640 persons toured the facility during this reporting period. Tour groups are usually given a brief orientation and/or demonstration by a member of the reactor staff.

Table 9 lists some of the major occasions or groups and number of visitors for each event.

Table 9. Public Relations Program

DATE	PARTICIPANTS	NUMBER
04/28/90	Spring Open House	92
05/01/90	Cub Scouts, Ron Olson	6
04/04/90	UMR Physics 107, Dr. Sparlin	62
05/15/90	Cuba 6th Grade	50
05/17/90	UMR Registrar and Admission Offices	13
05/22/90	Rolla Vo-Tech Business Class	16
06/08/90	Freshman Orientation Parents	8
06/11/90	Jackling Institute	41
06/15/90	Fundamentals of Engineering	77
06/18/90	Jackling Institute	37
06/18/90	Doe Run Company	34
06/22/90	Freshman Engineering	9
06/22/90	Beaumont High School	8
06/25/90	Jackling Institute	46
07/06/90	Boys Town of St. James	13
07/12/90	First Baptist Church Youth - Rolla	7

DATE	PARTICIPANTS	NUMBER
07/13/90	Summer Open House	66
07/17/90	Concordia Lutheran Church	56
08/09/90	Fundamentals of Engineering	97
09/25/90	UMR Introduction to Physics, Dr. Peacher	25
10/19/90	Florissant Senior Citizens	31
10/20/90	UM Rolla Day Open House	254
10/25/90	Society of Women Engineers	8
11/01/90	St. Louis Public Schools - 8th Grade	23
11/03/90	UMR Parents Day Tours	244
11/16/90	UMR ME 229	24
12/04/90	UMR NE 105, Dr. Mueller	15
12/07/90	UMR Physics 107	62
02/14/91	Raymondville 7 and 8 Grade	30
02/15/91	Rolla Middle School	42
02/19/91	St. Louis 8th Grade	12
02/23/91	Math Counts	8
03/28/91	Freshman Engineering	90
	TOTAL	1606

6.0 Education Utilization

Twenty-five UMR students, graduates and undergraduates, have participated in classes at the facility, utilizing 40 student-semester hours of allocated time. Additionally, students from several universities, colleges and high schools have used the facility.

The following is a list of scheduled classes at the facility along with associated reactor usage for this reporting period.

Course	Semester	Title	Credit Hours	Students	Reactor Hours
NE 105	Fall, 90	Fundamentals of Nuclear Engineering	2	14	13.7
NE 300	Fall, 90 & Winter, 91	Special Problems	1	2	1.9
NE 304	Fall, 90	Reactor Laboratory I	2	8	60.2
NE 306	Fall, 90 & Winter, 91	Reactor Operations	1	8	115
NE 308	Winter, 91	Reactor Laboratory II	2	7	26.8
NE 404	Winter, 91	UMC	2	11	4

The Reactor Sharing Program, funded by the Department of Energy, was established for colleges and universities which do not own a nuclear reactor. Additionally, high schools are allowed to participate. About 500 students and their instructors participated in this program. Table 10 lists those schools or similar groups that were involved in this year's program.

Table 10. Reactor Sharing Program

DATE	PARTICIPANTS	NUMBER
04/04/90	Hollister High School	25
04/05/90	Eminence High School	21
04/17/90	Rolla Vo-Tech Radiography, Rita Montgomery, Instructor	11
04/18/90	Benton County High School, Cole Camp, John Sode, Instructor	39
04/20/90	Potosi Gifted 8th Grade, Alan Ziegler, Instructor	10
04/23/90	John F. Hodge High School, St. James, Jim Jenkins, Instructor	16
04/24/90	Sullivan High School, Marcene Abel, Instructor	15
04/25/90	Vienna High School, Harvey Richards, Instructor	30
04/26/90	East Central College, Vera Luedde/Leroy Alt, Instructors	22
05/02/90	Rolla Vo-Tech Radiography, Rita Montgomery, Instructor	12
05/14/90	West Plains High School, Jack Dillard, Instructor	44
11/00/90	Kyle Mitchell, John F. Hodge High School, St. James	1
11/14/90	Whitfield High School, Tom Rodgers, Instructor	19
12/04/90	Parkway North High School, Jenny Shubert, Instructor	28
12/04/90	Van Buren High School, Daniel Freeman, Instructor	22
12/06/90	SMSU, Springfield, Howard Petefish, Instructor	4
01/18/91	Sasha Scott, Eldon High School, Individual	1
01/25/91	Travis Thomason, Houston High School, Individual	1
01/28/91	St. Charles Science Teachers	10
02/01/91	Angie Nicholson, Potosi High School, Individual	1
02/14/91	Stockton High School	6
02/14/91	Eureka High School	11

DATE	PARTICIPANTS	NUMBER
02/14/91	Springfield High Schools, Jon Feeney, Coordinator	17
02/20/91	Linn Technical College, Jack Light, Instructor	20
02/22/91	Therese Luna, St. James High School, Individual	1
02/25/91	UMC Nuclear Engineering, Jay Kunze, Instructor	12
03/04/91	St. Charles West High School, Rebecca Teague, Instructor	18
03/07/91	Hazelwood West High School, Gail Haynes, Instructor	14
03/11/91	Washington High School, Rick Swentker, Instructor	43
03/22/91	Stacy Drennon, Potosi High School, Individual	1
03/25/91	Crocker High School, Donna Burrow, Instructor	25
	TOTAL	500

7.0 Reactor Health Physics Activities

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

A. Routine Surveys

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

B. By-Product Material Release Surveys

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

C. Routine Monitoring

Twenty-eight reactor facility personnel and students involved with operations in the reactor facility are currently assigned film badges which are read twice each month for reactor staff and once a month for students. There are 4 area beta-gamma/neutron badges assigned. Twenty-two 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 21 monitor and spare badges assigned on campus. In addition, 4-7 direct-reading dosimeters are used for visitors and high radiation area work. There have been no significant personnel exposures during this reporting period.

Visitors are monitored with direct reading dosimeters. No visitor received in excess of 5 mrem.

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

Pool water activity is monitored monthly to ensure that no gross pool contamination nor fuel cladding rupture has occurred. Gross counts and spectra of long-lived gamma activity are compared to previous monthly counts. From April 1990 through March 1991 sample concentrations averaged 1.05×10^{-5} µCi/ml.

D. 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 171.06 millicuries were released into the air. The released isotope was identified as Ar-41.

Solid waste, including used water filters, used resins and contaminated paper is stored and/or transferred to the campus waste storage area for later shipment to a commercial burial site. Radioactive waste released to the sanitary sewer is primarily from regeneration of the ion-exchange column. During this period 9 releases associated with resin regeneration were discharged to the sanitary sewer totaling approximately 37,570 gallons of water with a total gross activity of less than 1.413 millicuries.

E. Instrument Calibrations

During this period, portable instruments and area monitors were calibrated twice.

8.0 Plans

The reactor staff will be heavily involved in 4 major projects during the next reporting period; 1) preparing for receipt of the LEU fuel, 2) procuring, testing and bringing on-line the new reactor nuclear instrumentation, 3) preparing to ship HEU fuel offsite, and 4) solicitation of new reactor users to increase reactor utilization.

A. LEU Fuel Conversion

On March 5, 1991 we received the NRC order to modify our license to convert from HEU to LEU effective upon the date of receipt of the LEU fuel. Currently, we plan to receive "dummy" elements this summer and receive the LEU fuel sometime next summer.

When the dummy elements are received they will be rigorously tested to assure dimensional compatibility with our gridplate, control rods, and experimental facilities.

A detailed start-up testing plan will be prepared to cover loading and testing of the new LEU core.

B. Reactor Instrumentation Upgrade

Efforts are currently underway to procure new nuclear instrumentation to replace our current Start-up, Linear, and Intermediate instruments. This upgrade is partially supported under a grant from DOE.

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

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

C. <u>Shipment of HEU Fuel Offsite</u>

Efforts will continue during the next reporting period to prepare for offsite shipment of our HEU fuel. We hope to maintain the HEU fuel for a period of about 1 year after discharge to allow for radioactive decay. Studies are currently underway to project the dose rates that will be associated with each element.

Additionally, we plan to submit a revised Security Plan for NRC review and approval to relax our current security requirements associated with the HEU fuel.

D. <u>Reactor Utilization</u>

Increasing reactor utilization is a high priority at UMRR. Plans to increase our efforts in soliciting more on-campus and off-campus users are underway. These plans include seminar presentations to various departments on the UMR campus and to area universities and colleges. Additionally, certain service oriented organizations will be solicited.

APPENDIX A.

STANDARD OPERATING PROCEDURES

CHANGED DURING THE PAST YEAR

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A. <u>Purpose</u>

The purpose of this document is to set forth the procedures for routine and emergency operations of the University of Missouri-Rolla Reactor. The goal of these procedures is to assure that the UMRR will be operated safely, presenting no hazard to the public or to the operating staff, and secondarily, that reactor equipment will be safeguarded. It is mandatory that all personnel involved with reactor operations be completely familiar with these procedures and that these procedures be followed.

B. <u>Precautions, Prerequisites, or Limitations</u>

1. These procedures are intended to reflect and implement Facility License Number R-79, as amended, and Title 10 of the Code of Federal Regulations.

2. Only two copies of the SOPs are to be considered controlled copies. The controlled copies shall contain all of the approved procedures and will incorporate new or revised procedures as they are approved. The controlled copies should be retained in the office reception area (Reactor Manager's Copy) and in the Control Room (Control Room Copy). All other copies of SOPs are to be considered complimentary only and shall not be used for facility evolutions.

3. The SOPs shall be reviewed annually by either the Reactor Manager, Reactor Director, or a licensed operator. Identified weaknesses, inadequacies, or recommendations for improvements should be discussed with the Reactor Manager to determine if revision to the SOPs is required.

4. Changes that do not change the original intent of the procedures may be made with the approval of the Facility Director.

5. Substantive changes to the approved procedures shall be made only with the additional approval of the Radiation Safety Committee.

Written By: David Freeman Approved By: Albert Bolon

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A. Purpose:

To provide written procedures for routine reactor operation. Rev.

B. Precautions, Prerequisites, or Limitations:

1. Reactor operations must at all times meet the requirements of the Facility License R-79, Technical Specifications, and the Physical Security Plan.

2. At least two persons, one of whom is a Senior Operator, shall be present in the Reactor Building when the reactor is operating.

3. A licensed operator responsible for reactor operation shall be present in the control room at all times when the reactor is operating.

   a) Students may operate the reactor controls under the direct supervision of a licensed operator provided the excess reactivity is less than 0.7% delta k/k.

   b) Trainees may operate the reactor controls under the direct supervision of a Senior Operator provided the excess reactivity is less than 1.5% delta k/k.

4. The reactor will be operated with the minimum amount of excess reactivity necessary to fulfill operational requirements, and those requirements will be at the direction of the Senior Operator on Duty.

5. Personnel in the Reactor Building should be informed over the public address system about changes made to the reactor status.

6. 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.

7. All personnel are responsible for notifying the Senior Operator on Duty of any work being done that could either directly or indirectly affect reactor operations. Rev.

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8. Radioactive samples or sources will be removed from the core or thermal column only under the direction of a Senior Operator, or the Campus Health Physicist (or his designated representative). Rev.

9. 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.

10. 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.

11. Changes in Core Mode (T or W) will be noted in the permanent log book, including date and time. Rev.

12. Only the Senior Operator on Duty may key bypass control channel automatic functions. The use of any interlock bypass key requires a permanent log entry for insertion and removal. This log entry shall include date and time.

13. Handwritten revisions to the Controlled SOPs may be made provided the following conditions are satisfied:

    a) Handwritten revisions are clearly legible and neatly made in red ink in both Control SOPs.

    b) Handwritten revisions are reviewed and approved by both a Senior Operator and the Reactor Director. Review and approval shall be documented by initialing and dating the revision.

    c) Handwritten revisions should be listed on the revision form located in the front of the Reactor Manager's controlled copy of SOPs in red ink.

    In the absence of the Reactor Director, the Reactor Manager may review and temporarily approve handwritten revisions provided the Reactor Director reviews the revision as soon as practical upon his return.

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14. Any abnormal behavior associated with reactor startup or operation should be reported to the Senior Operator on Duty immediately. If there is any doubt about reactor safety, the reactor shall be shut down. Then the cause should be determined and corrective action taken. Rev.

15. Only a Senior Operator can give permission to restart the reactor after a scram or rundown.

16. The Standard Operating Procedures (SOP's) should be followed to the extent practicable, especially whenever the pre-startup checklist is being completed, when the reactor is being started, or when the reactor power is being changed.

17. The Senior Operator on Duty has the authority to instruct the reactor operator to disregard certain SOP's provided that no safety requirements are violated. (For example SOP 305 does not have to be performed every pre-startup checklist.)

18. All scrams and rundowns shall be noted with explanation of the cause and corrective action in the permanent log book. Rev.

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A. Purpose:

The purpose of the checklist is to give assurance that systems are operating correctly. The checklist shall be completed any time the reactor is to be started up from a complete shutdown, that is if a shutdown checklist has been completed, unless otherwise specified by the Senior Operator on Duty. Rev.

B. Precautions, Prerequisites, or Limitations:

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

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

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

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

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

C. Procedure

Refer to the pre-startup check list.

1. Use the rubber date stamp.

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

3. Your initials.

4. Enter core loading number and mode.

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

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

7. Check the #1 Radiation Area Monitor (RAM) at its respective setpoint, i.e. ~13 mr/hr "High Radiation Alarm" and ~20 mr/hr "Building Evacuation Alarm." Depress the button on #1 RAM Amplifier and hold until the board annunciator and building alarm sound. Push scram reset, acknowledge, and reset buttons in that order. Repeat for #2, and #3 RAM, except there will be no building evacuation alarm. Push acknowledge, and board reset. Announce, "Test complete, acknowledge all further alarms." | Rev.

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

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

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

This completes the preliminaries.

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

11. Depress the zero check button. If the digital readout is not ".0000", notify the S.O. Depress the zero check button again to release the check function. If the linear reading is not between 0.02 to 0.05, ask the Senior Operator on Duty to adjust the compensating voltage. Record the meter reading. Record the scale.

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

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

14. Turn the pool lights on. Check the water level in the pool. "Spike" the Log N and period CIC and the Linear CIC by positioning the neutron source next to the detectors. Check that the period, Log N and linear recorders have responded properly. Reset the board. Insert the source in holder. Look at the core and pool for foreign objects that may have fallen in. Check the in-core experiments. If you received < 5 sec signal, reset the period light on the amplifier. Rev.

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

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

17. Turn on scaler, reset the timer, make sure it is counting.

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

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

20. Turn switch on Log N meter to "LOW". (The Log N recorder should read about 0.01.) Quickly turn switch to "HIGH". (The recorder should read about 8 kW.) Push acknowledge and board reset.

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

This completes the "static test" of the instruments.

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

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

23. Record magnet readings using the current gauges located above the safety amp. (Typical readings should be between 35 and 85.) Rev.

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

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

25b. Period < 5 Seconds Test Rev.

a. Withdraw rods to 3 inches.

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b. Push in and turn trip test knob on the period section of the Log N Amplifier. Rev.

c. Rotate the trip switch slowly and observe that the 30 second rod withdraw prohibit annunciator is actuated with a simulated period ≤ 30 seconds. Continue to rotate the trip switch and observe that the 15 second period rundown occurs with a simulated period ≥ 15 seconds. Continue with trip test button rotation until the period light is illuminated on the Log N Amplifier.

d. Acknowledge the annunciator alarm and observe period < 5 second scram occurs at a value ≥ 5 seconds. Also observe the 150% Full Power Scram and that the safety rods have dropped. Reset the period trip test light on the Log N Amplifier and push the rundown reset buttons. Insert rod drives and reset annunciators.

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

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

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

29. Prepare hourly and permanent logs.

30. Raise shim/safety rods to 6 inches. Record the time in <u>both logs</u>.

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

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

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

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

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

36. Use the rubber date stamp, in case page 2 of the check-list should be separated from page 1.

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UMRR PRE-STARTUP CHECK LIST
(SOP 102)

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

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UMRR PRE-STARTUP CHECK LIST
Page 2

17. Scaler on Count and Counting						
18. Check Fission Chamber Response						
19. Fission Chamber on Insert Limit and Count Rate Greater than 2 CPS						
20. Test Log N Recorder Response						
21. Test Period Recorder Response						
22. Magnet Power On, Scram Reset, Board Reset						
23. Magnet Currents (Read Values)	No. 1					
	No. 2					
	No. 3					
24. Check 150% Power Scram	Raise Rods 3 in. Push "Test" Button On Safety Amp Panel					
25. Check Log N/ Period Non-Operative Scram and 15 sec Period Rundown	Raise Rods 3 in. Select Switch to Calibrate					
25b. 5 sec period scram						
26. Test Manual Scram	Raise Rods 3 in. Push Manual Scram					
27. Test Annunciator, All Lights On						
28. All Magnet Contacts Made, Reg. Rod on Insert Limit						
29. Prepare Hourly and Permanent Logs						
30. Raise Rods to 6 in., Record Time						
31. Inspect Core						
32. Announce Intention to Start						
33. Intended Power Level						
34. Pre-Startup Check Completed						
35. Senior Operator's Initials						
36. Date						

Rev.

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A. PURPOSE

The purpose of this procedure is to provide guidance for performing the resin regeneration and associated sample collection. Rev.

B. PRECAUTIONS, PREREQUISITES, OR LIMITATIONS

1. Inform the Reactor Manager that the regeneration is being started. Rev.

2. Two personnel should be present dressed in lab coats and eye protection for all caustic and acid transfers.

3. The Reactor Manager should be informed when the system is returned to service. Rev.

4. Ensure water flow to the make-up sump is maintained to prevent draining of make-up sump which would cause air to be sucked into the demineralizer.

5. WATCH LEVEL WHEN USING ACID AND CAUSTIC TANKS TO ENSURE THAT NO AIR IS DRAWN INTO THE SYSTEM WHEN THE LEVEL IS LOW.

6. Each step must be performed in a timely manner to prevent a faulty regeneration.

7. SOP 205 must be used in conjunction with this procedure.

8. The numbers referred to in this procedure are the valve numbers found on the valve tags.

9. Sampling of liquids sent to the retention tank should consist of three grab samples collected at the beginning, middle, and end of each process (i.e. backwash, caustic rinse, and acid rinse). Sampling of liquids discharged to the sewer system may consist of either grab sampling as described above or "trickle" sampling using a continuous draw sample collection technique during discharge. Rev.

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C. PROCEDURES

1. Check that the following valves are closed: 30, 31, 32, 33, 34, 35, 36. 37, 39, and 40.

2. STOP PUMP. Isolate purification system from pool by: closing 19, 22, 25, 3, and 1.

3. Open 13. Fill make-up sump to lower overflow hole. Adjust 13 to maintain level.

4. Open 17. Check 18 is shut.

5. Isolate demineralizer: Close 2, 9, 5, 7, 11, and 4.

6. Align retention tank #2 to accept backwash water. Open valves 31, 35, and 30.

7. Backwashing resins:
   a) Open 5 and 4
   b) Start pump
   c) Open 1 to maintain flow @ 10 gpm
   d) Close 30 until pressure increases or flow decreases
   e) Maintain full sump level with 13
   f) Obtain a backwash sample from 38 at the beginning, middle, and end of the backwash to the retention tank Rev.
   g) Leave 38 open to check for no resin beads present
   h) Backwash for minimum of twenty minutes to separate beads

8. Prepare caustic while backwashing.
   a) 45 pounds (7 inches) of NaOH placed in caustic tank (tank on pump side of demineralizer).

9. To stop backwash:
   a) Close 30, 1, 38, 4, and 5
   b) STOP PUMP
   c) Wait for resins to completely settle
   d) Open plug (below valve 10) to drain resin from spreader

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10. a) Record the volume (gallons) of backwash sent to the retention tank. Rev.
 b) The backwash sample collected in Step 7f) must be analyzed and the appropriate release authorization signature must be obtained (per SOP 205) prior to discharging backwash water from the retention tank.
 c) After release authorization has been obtained for the backwash water in the retention tank, additional backwash water may be discharged directly to the drain, provided it is sampled and analyzed within 24 hours of the release. If additional backwash is discharged, record the volume (gallons), date, and time of release.
 d) Discharge to sump by: closing 31, and 35; opening 33, and 37

11. Regenerating anion bed (watch tank level):
 a) Open 34 (to retention tank #1)
 b) Open 9, 11, and 30
 c) Start pump
 d) Open 1 to obtain 34 psig on bottom gage
 1. Adjust 4 to lower pressure to 20 psig
 2. Adjust 1 to raise pressure to 34 psig
 3. Close 30 until pressure starts to increase
 e) Open 10 to siphon caustic
 1. Regulate siphon rate to approximately 1 to 1.5 in/min
 2. Should be completed in approximately 30 min.
 3. Obtain samples at 5, 10, and 20 min. Rev.
 f) When caustic tank is empty, close valve 10

12. Anion Slow Rinse
 a) Rinse for 30 min. at approximately 34 psig on bottom gage
 b) Ensure valve 4 is cracked open

13. Anion Fast Rinse (Caution: make-up sump level will drop)
 a) Close 9 while opening 2
 b) Adjust 1 to approximately 30% (top gage)
 c) Rinse for 30 min.
 d) To start fast rinse:
 1. Close 35
 2. Open 32

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3. Adjust 30 for 25 psig
e) Prepare acid while fast rinsing
1. Fill acid tank with HCl to within 4 in. of top
f) TO STOP FAST RINSE:
1. Close 1, 4, 2, and 11
g) Record the volume (gallons) of anion rinse sent to the retention tank. Rev.
h) In the event that retention tank #1 is full and additional anion rinse is required, the additional anion rinse water may be discharged to the drain, provided it is sampled and analyzed within 24 hours of the release. If additional rinse water is discharged, record the volume (gallons), date, and time of the release.

14. STOP PUMP

15. Regenerating Cation Resins:
a) Lineup retention tank #2 by:
1. Closing 34 and 32
2. Opening 35
b) Open 6 and 8
c) Start pump
d) Adjust 1 to 20 psig (bottom gage)
e) Open 7
f) Close 30 until pressure increases
g) Adjust 7 for a 1 to 1.5 in/min siphon rate of acid tank
h) Obtain samples from valve 38 at 5, 10, and 20 min. intervals Rev.
i) When acid tank is empty:
1. Close 7

16. Cation Slow Rinse:
a) Rinse 15 min. at 20 psig

17. Cation Fast Rinse
a) STOP PUMP
b) Close 1, 8, and 6
c) Open 4, 11, and 1
d) Rinse 15 min. at 30% flow
e) Record the volume (gallons) of cation rinse sent to the retention tank. Rev.

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f) In the event that retention tank #1 is full and additional cation rinse is required, the additional cation rinse may be discharged to the drain, provided it is sampled and analyzed within 24 hours of the release. If additional rinse water is discharged, record the volume, date, and time of the release. Rev.

18. Full Bed Rinse:
    a) Close 4, 11, and 1
    b) Open 2, 8, and 1
    c) Rinse 15 min. at 30% flow
    d) Start air compressor

19. STOP PUMP

20. Close 2, 8, 1, and 11

21. Close 13 (to makeup sump)

22. Draining Resin Bed (level drops quickly with air)
    a) Open 2 and 8
    b) Drain to 1/2 inch of top of resin
        1. Valves 12 and 12A can be used to allow air pressure to enter
    c) Close 12A, 8, and 2
    d) Open 5 (release air pressure)

23. Start pump

24. Open 4

25. Slowly open 1

26. Refill resin 1 inch above top of resin bed

27. STOP PUMP

28. Close valve 1

29. Remixing Resin:
    a) Slowly open 4, 5, and 12
    b) Mix resin beads thoroughly

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30. Close all valves

31. Allow beads to settle

32. Refill of Demineralizer:
    a) Open 9
    b) Start pump
    c) Crack open valve 1
        1. Obtain 30 psig (lower gage)
        2. Continue for 15 minutes
    d) Open 2
        1. Pump at 40% flow until demineralizer is full
        2. Remove air at regular intervals while filling by:
            a. Closing 1
            b. Opening 5
    e) Close 9

33. Final Rinse:
    a) Open 2 and 8
    b) Open 1 to 60% flow
    c) Rinse resin until 500,000 ohm-cm is obtained
    d) If not obtained in 45 minutes:
        1. Close 1, 8, and 2
        2. Open 4 and 5
        3. Open 1 to approximately 5% flow for 2 min.
        4. Close 1, 4, and 5
        5. Allow resin to settle
        6. Repeat step 33.a.
    e) Rinse water may be discharged to the drain, provided it is sampled and analyzed within 24 hours of the release. If final rinse is discharged, record the volume (gallons), date, and time of release. Rev.
    f) Close 2 and 13
    g) STOP PUMP
    h) Close 8

34. Restart Recirculation to Pool
    a) Close 13
    b) Open 19 while closing 17

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35. Discharging to Basement Sump:
    a) Samples must be analyzed and release approval obtained per SOP 205 | Rev.
    b) Close 30 and 35
    c) Open 32, 33, and 37
    d) Observe sump levels
        1. Adjust 33 to prevent overflow condition
    e) When tanks are empty:
        1. Open 30, 31, 32, and 33
        2. Close 36 and 37
    f) Record the volume (gallons), date, and time of each release | Rev.

Written By: David Freeman Approved By: Albert Bolon

A. PURPOSE

To provide instruction on the analysis and discharge of demineralizer regeneration waste water.

B. EQUIPMENT

15 ml plastic vials

15.5 ml Co-60 standard (UMR-1, #11)

15 ml vial of Reactor Facility tap water (background)

Multichannel analyzer with Germanium or

Sodium Iodide detector.

C. ANALYSIS PROCEDURE

1. Obtain each sample as required in SOP 204.

2. Label and date each vial. (e.g. Acid, Caustic, Backwash, Dilution, etc. and Month/Day/Year.)

3. Samples of liquids stored in holdup tanks should be analyzed within one week of collection. The results of this analysis may be used for reporting purposes when the tanks are discharged; however, credit for decay may be taken by reporting the results of a re-analysis performed on the sample on or before the day of release.

4. Samples should be retained for a period of 6 months.

5. Count the Co-60 standard (UMR-1, #11) for at least 300 seconds, 600 seconds (live time) or longer is preferred. Print out the gross integral counts between 0 and 2 MeV and the net integrals for the isotope peaks. Record the error in the gross count integral between 0 and 2 MeV on the printout.

6. Count the tap water (background) in the same geometry and for the same length of time as the standard. The background determination should be made at least once every four hours during analysis. Print out the gross integral between 0-2 MeV. Record the error on the printout.

Written By: David Freeman Approved By: Albert Bolon

7. Count the sample(s) in the same geometry and for the same length of time as the standard. (The standard, background and sample(s) should be counted in succession with no excessive delays between counts.) Print out the gross integral between 0-2 MeV. Record the error on the printout. If any isotopes are identified in the sample, print out the net integral for each peak. If no peaks are present, note it on the print out.

8. If isotope peaks are identified in the sample, re-analyze the background spectrum (previously collected) and determine if peaks exist in the background at the same energies, if so, subtract the background net integral peak counts from the sample net integral peak counts to determine if the sample peak is significantly above background. If sample peaks are determined to exist above background, list their energies and try to identify the isotope(s) on the "Regeneration Waste Water Analysis and Release Authorization Form".

9. Complete the "Regeneration Waste Water Analysis and Release Authorization Form". Use the gross integral count rates between 0 to 2 MeV for the efficiency and sample activity determinations. Attach all supporting documentation (clearly labeled) to the "Regeneration Waste Water Analysis and Release Form".

D. <u>DISCHARGE PROCEDURE</u>

1. Obtain the appropriate authorization signature for release using the criteria below:

   a. The Reactor Manager or the Health Physicist (or his designee) may authorize the release (by signature) if no radioisotopes are identified above background and the gross activity is less than 1.5×10^{-5} µCi/ml above background.

   b. If any radioisotopes are identified above background or if the gross activity of the sample is greater than 1.5×10^{-5} µCi/ml above background, the Health Physicist (or his designee) must authorize (by signature) the release.

Written By: David Freeman (signature) Approved By: Albert Bolon (signature)

c. The release authorization signature must be obtained prior to discharge with the exception of dilution wash and rinse water. The authorization signature for dilution wash and rinse water should be obtained within 3 working days after the release.

Dilution wash and rinse water has been shown to meet the release criteria above and may be released without prior analysis on the condition that this water is sampled per SOP 204 and analyzed within 24 hours of the release. In the unlikely event that the average activity of the dilution wash and rinse water exceeds 1.5×10^{-5} μCi/ml, the Reactor Manager and Reactor Director should be notified.

2. Release the liquid. Record the date, time, and volume of the release. If discharging dilution wash and rinse water, sample the discharge per SOP 204.

3. Attach a copy of the spectral analysis printouts to the completed "Regeneration Waste Water Analysis and Release Authorization Form". Forward a copy of the completed form to the Health Physicist. File the original form with attached printouts in the Reactor Facility files.

Written By: David Freeman Approved By: Albert Bolon

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Regeneration Waste Water Analysis and Release Authorization Form

Sample Description:________________
Sample Collection Date:________________
Sample Volume (ml):________________
Analysis Date:________________

I. Efficiency Determination

Source Identification Co-60, UMR-1, #11
Initial Source Activity (A_o): 1.88×10^{-2} μCi on 10/1/78
Decayed Source Activity A(t): ________ μCi
Fixed Geometry Description ________________

Source ct rate	________	±	________	cpm
- Background ct rate	________	±	________	cpm
Differential ct rate	________	±	________	cpm

$$\text{Efficiency (eff)} = \frac{\text{Differential CR}}{(2\gamma/\text{dis})(A(t)\ \mu\text{Ci})} = \_\_\_\_ \pm \_\_\_\_ \frac{\text{cpm}}{\mu\text{Ci}}$$

II. Sample Activity Determination

Sample ct rate	________	±	________	cpm
- Background ct rate	________	±	________	cpm
Differential ct rate	________	±	________	cpm

$$\text{Sample Activity} = \frac{\text{Differential ct rate}}{(\text{eff}) \times \text{sample volume (ml)}} = \_\_\_\_ \pm \_\_\_\_ \frac{\mu\text{Ci}}{\text{ml}}$$

III. Peak Identification

Energy	CPM (above background)	Nuclide

IV. Approval for Release:

Signature ________________ Date & Time ________

Actual Release Date & Time________________
Volume of Release________________

Written By: David Freeman
David Freeman

Approved By: Albert Bolon
Albert Bolon

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In the event of any disorder on the campus of the University of Missouri-Rolla such as civil strife or demonstrations which could for any reason have an effect on the security of the Reactor Facility the following steps will be observed: Rev.

1. The reactor shall be shutdown and the magnet power key secured in its normal storage location. Rev.

2. All entrances to the building shall be locked 24 hours per day. Only persons who can be identified and have a need to be in the building will be admitted.

3. Access to the main office will be allowed only after visually observing the person to ensure no unauthorized people are present.

4. The Senior Operator on Duty shall lock the Reactor Confinement Security Door. Del.

5. The Senior Operator on Duty will notify the Highway Patrol, City Police, and Campus Police, respectively. The Fire Department should be notified, if necessary.

6. The reactor staff shall not enter into any confrontation with any persons, except to provide for personal safety.

Written By: David Freeman

Approved By: Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 510 TITLE: EARTHQUAKE

Revised: September 12, 1990

EARTHQUAKE IN IMMEDIATE VICINITY OF REACTOR BUILDING

1. SCRAM the reactor and secure the magnet power key.
2. If danger is immediate, personnel should seek cover under tables, desks or in strong doorways away from glass, heavy bookcases or shelves.
3. If time permits, personnel should evacuate building to open area east of Reactor Building.
4. Prior to re-entering the building, conduct a radiation exposure rate survey to identify possible abnormal radiation levels.
5. Re-establish physical security as soon as possible.
6. Be prepared for "aftershocks" that may pose additional danger.

Written By: David Freeman

Approved By: Albert Bolon

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A. PURPOSE

To ensure that proper transport, handling, and shielding requirements and regulations are observed in the shipping or releasing of radioactive materials to licensees on campus.

B. PRECAUTIONS, PREREQUISITES, OR LIMITATIONS

1. All shipments or releases of by-product material from the Reactor Building shall be handled as "limited quantity" -- if possible. Any amounts greater than "limited quantity" require special attention as deemed by Health Physics.

2. The person receiving radioactive material must show that he/she is licensed to possess it. Radioactive materials can not be released to someone who is not licensed.

3. If there are any questions pertaining to the release of a material, or whether a substance is considered to be "limited quantity", the campus Health Physicist should be notified.

C. PROCEDURES

1. Check D.O.T. 173.423 and 173.421 to ensure that the radioactive material meets the requirements of "limited quantity".

2. Package the radioactive material in double containers. Check the package to ensure that the materials are packaged in strong, tight containers such that there will be no leakage of radioactive materials under conditions normally incident to transportation.

3. Check the outside of the inner container to be sure that it bears the marking "Radioactive Material".

4. Check the radiation levels to ensure that the dose rate at any point on the external surface of the outer package does not exceed 0.5 mr/hr.

Ray Bono

Written By: Ray Bono

Albert Bolon

Approved By: Albert Bolon

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5. Swipe the outside of the outer package for contamination and count the swipes. The swipes must not be >220 dpm/cm^2 for beta/gamma or >22 dpm/cm^2 alpha (if applicable). Rev.

6. Fill out a Material Transfer Form (see the attached). Make two additional copies. One goes with the carrier, one goes to the Health Physicist and one goes into the Reactor files.

7. Check the cosignees license before releasing the radioactive material to be sure they are authorized to receive it.

Written By: Ray Bono Approved By: Albert Bolon

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MATERIAL TRANSFER FORM

Ship To________________________ Consignee By Product License

________________________ Number________Exp Date________

TARGET MATERIAL	WEIGHT	PHYSICAL FORM	RADIONUCLIDE	ACTIVITY (IN CURIES)	TRANSPORT GROUP

GAMMA DOSE RATE ____________________ DATE IRRADIATION ____________

TYPE SHIPMENT ____________________ ____________

SHIPPING CONTAINER ____________________ LABELS ________ ____________

TRANSPORT ROUTING ____________________

DOSE RATE
AT SURFACE ________________mr/hr
AT 3 FEET ________________mr/hr
INSTRUMENT USED ____________________
HEALTH PHYSICS APPROVAL ____________

SURFACE CONTAMINATION
BETA/GAMMA __________dpm/cm² Rev
ALPHA ______________dpm/cm² Rev
(If applicable)
INSTRUMENT USED ____________
DATE ____________________

"This package conforms to the conditions and limitations specified in 49CFR173.421 for excepted radioactive material, limited quantity, N.O.S. UN2910." Rev

CERTIFIED BY ______________________________ DATE ____________

ACCEPTED BY CARRIER ______________________ DATE ____________

Ray Bono
Written By: Ray Bono

Albert Bolon
Approved By: Albert Bolon

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A. PURPOSE

To ensure the proper operation of the control and safety-related instruments of the reactor and to functionally test the Physical Security Alarm System. Rev.

B. PRECAUTIONS, PREREQUISITES, OR LIMITATIONS

1. The Weekly Check should be completed on the first working day of each week the reactor is to be operated. The Physical Security Alarm System shall be checked regardless of reactor status.

2. The Physical Security Alarm System should be functionally tested for proper operation (per Section C.11) on the first work day of each week. The interval between tests is not to exceed 10 days.

3. The weekly check should be performed by a licensed operator, or a student under the direct supervision of a licensed operator.

4. Complete the Weekly Surveillance Checklist form (Form SOP 810), and forward it to the Reactor Manager (or Director) for review and signature. Any abnormalities, problems, or out of service equipment should be brought to the attention of the Reactor Manager (or Director).

C. PROCEDURE

Select the Reactor Bridge Station on the Building Intercom, check the PA system, install the neutron source, turn on all 5 primary recorders (date the recorders), turn on core camera and select core on the monitor selector. Obtain Magnet Power Key and turn on magnet power.

1. ROD WITHDRAW PROHIBIT (yellow lights):

   A. Recorders off ... the ods will not withdraw if any one of 5 primary recorders is turned off.

Written By: Carl Barton Approved By: Albert Bolon

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

B. Log Count Rate < 2 CPS.

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

C. Period < 30 Seconds

1. Depress "Test Trip" switch on Log N & Period Amplifier and adjust for a period < 30 seconds. Record value at which alarm occurs on the recorder.
2. Attempt to withdraw rods.
3. Release test switch, reset alarm.

D. Inlet Temperature Above 135 Degrees

1. With recorder on, remove back cover and manually rotate potentiometer arm until alarm occurs, record trip point.
2. Acknowledge alarm and attempt to withdraw rods.
3. Reset alarm on temp. recorder, reset alarm on console.

E. Shim Rods Below Shim Range

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

2. <u>RUNDOWN CHECK (blue lights)</u>:

A. Radiation Area Monitoring (RAM) System

1. Withdraw rods to 3 inches.
2. Announce "The Building Alarm will sound. This is a test do not evacuate the building." on the Building PA System.
3. Using RAM check source switch #1. Note the value at which alarm(s) occurs. Check the automatic reset of the RAM, reset the Building Alarm, (Scram Reset Button), acknowledge annunciator Rundown Reset and Annunciator Reset. Record value of alarms.
4. Repeat step 3 for RAMs #2 and #3.
5. All alarms values shall be $\leq$ 20 mr/hr.
6. Upon completion of testing announce "Test Complete. Acknowledge all further alarms," on the building PA system.

B. 120% Demand

1. Withdraw rods to 3 inches.
2. De-energize (Linear, Period or Log N) recorder. (Switch to off.)
3. Remove Linear Channel potentiometer cover and manually rotate potentiometer arm, note recorder reading when trip point is reached. |Rev.
4. When inward motion of rods is verified, lower recorder below reset point, reset the rundown and all alarms, turn recorder on and replace cover, compare actual and specified trip

points.
5. Record trip point value.

C. Period < 15 Seconds

1. Repeat steps 1 through 5 of 2.B for the Period recorder.

D. 120% Full Power

1. Repeat steps 1 through 5 of 2.B for the Log N Recorder.

E. Low CIC Voltage Linear Power Supply

1. Withdraw rods to 3 inches.
2. Push and hold alarm test button on Linear CIC Power Supply. Observe High Voltage meter and record the value when the under voltage alarm light comes on. Release the test button.
3. Acknowledge the annunciator alarm and observe Low CIC voltage annunciator light. Check for insertion of control rods (rundown in progress).
4. When the High Voltage on the Linear CIC Power Supply has increased to approximately 500 volts push alarm reset. The under voltage alarm light will go off allowing the operator to reset the rundown (push rundown reset) and the annunciator.
5. Record value of the trip point.

F. Low CIC Voltage Log N Power Supply

1. Withdraw the rods to 3 inches.
2. Push and hold alarm test button on the Log N CIC power supply. Observe the high voltage meter and record the value when the under voltage alarm light comes on. Release the test button.
3. Acknowledge the annunciator alarm and observe the Low CIC Voltage annunciator light (also check for ≤ 5 sec. period, ≤ 15 sec. period, <

30 sec. period, and 150% full power). Reset the period trip light on the Log N & Period Amplifier. This allows for reset of all annunciator lights except low CIC voltage.

4. When the High Voltage on the Log N CIC power supply has increased to approximately 500V, push alarm reset. The voltage alarm light will go off allowing the operator to reset the rundown (push rundown reset) and reset the annunciator.
5. Record value of trip point.

G. Regulating Rod on Insert Limit on Auto

1. Withdraw the Shim/Safety rods to 3 inches and Reg Rod to 0.5 inches (use the shim range bypass).
2. Adjust Linear recorder setpoint so that "auto permit" comes on.
3. With regulating rod at approximately 0.5 inches withdrawn, switch the Reg Rod control to "Auto" and reset the annunciator.
4. Adjust the red pointer (auto setpoint) to be slightly below black pointer (Linear signal) so that an insert on the Reg Rod will result.
5. When the Reg Rod reaches insert limit observe Manual Operation and "Reg Rod insert limit on Auto" annunciators.
6. Acknowledge and reset rundown and annunciators.
7. Record results.

3. <u>SCRAM (red lights)</u>:

A. Bridge Motion scram

1. Withdraw rods to 3 inches.
2. Release bridge lock and move the bridge a small distance.
3. Observe a Bridge Motion, Manual Scram and Magnet contact lights off. Acknowledge the annunciator alarm.
4. Return bridge to original position and reset all annunciators. Re-insert the magnets.

5. Record results.

B. Period < 5 Seconds

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

C. Log N & Period Non-Operative Scram

1. Withdraw rods to 3 inches.
2. Turn Log N test from the operate to high or low position.
3. Observe Log N Period Amp Non-Operative Scram, Manual Scram, and that the Magnet contact lights go out. Acknowledge annunciators. Reset Manual Scram and reset annunciator. Insert the magnets. | Rev.
4. Record results.

D. 150% Full Power Scram

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

4. Reset annunciator and insert the magnets.
5. Record results.

E. Manual Scram

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

4. ROD DROP CURRENTS:

1. Withdraw rods to 3 inches.
2. Using a screwdriver slowly reduce magnet current using current adjustment #1, until the #1 magnet contact light goes out (you should also hear an audible "click" from the Reactor Bridge Intercom Station). Record this drop current value. Rev.
3. Repeat Steps 1 and 2 for Shim Rod No. 2 and No. 3.
4. Insert all Shim Rods to insert limit.
5. Set all Magnet Currents to "normal" (i.e. Drop Current plus 10 ma).

5. TEST OF ANNUNCIATORS:

A. Beam Room High Neutron Flux

1. Lower alarm set point by turning red needle on log rate meter to the left. Alarm occurs when black needle is hard against the red needle.
2. Check for local red alarm light and for white annunciator light on control panel. Return red needle to normal (10K) set point, reset alarm and annunciator.
3. Record results.

B. Interlock Bypass

1. Bypass each interlock one at time to ensure that each individual bypass operates the annunciator and the bypass lights.

C. Servo Limits

1. Note linear level recorder reading.
2. Change the automatic set point for auto permit by adjusting the star wheel. Note linear level at which light comes on (<+2%). Continue to lower and note reading until the auto permit light goes off (> -2%).
3. Reset automatic set point to the 100% level.
4. Record results.

D. Pool Demineralizer Effluent Conductivity High

1. Have an individual station him (her) self at the conductivity monitor and select the intermediate level station on the building intercom.
2. Have the individual select "Meas B" (Demineralizer Effluent) and then reduce the setpoint value until the red (low) alarm light comes on. At this time the annunciator should also alarm.
3. The Control Room Operator should then inform the individual stationed at the demineralizer to return the setpoint to the 0.5 Megaohm value (green light should come on).
4. With this step complete return building intercom to normal status, reset the annunciator.
5. Record results.

6. <u>"REACTOR ON" LIGHTS:</u>

A. With Magnet key inserted and all scrams reset check the "reactor on" lights (1) above console (2) at reactor entrance and (3) basement level.

Carl Barton
Written By: Carl Barton

Albert Bolon
Approved By: Albert Bolon

7. BUILDING EVACUATION ALARM:

   A. Announce over the PA, "The Building Alarm will sound. This is a test. Do not evacuate the building."
   B. Push the Building Evacuation Alarm (center) of reactor console) and note the audible alarm.
   C. Reset Building Evacuation Alarm by pushing Scram Reset.
   D. Announce over building PA "Test alarms complete. Acknowledge all further alarms."

8. NITROGEN DIFFUSERS:

   A. With the bridge intercom station selected, start diffuser #1. The green operation light should illuminate. Note the sound level of the pump and no unusual noise.
   B. Shutdown the #1 pump and repeat step 1 for the #2 nitrogen diffuser.
   C. Record results on form SOP 810.

9. BEAM PORT AND THERMAL COLUMN WARNING LIGHTS:

   A. Announce over the building PA. "Attention personnel, stand clear of the Beam Port".
   B. Open the Beam Port by holding the beam port control switch in the open position until the "Red" (open) light comes on.
   C. Acknowledge the annunciator alarm and check the Basement Level Warning Light (Flashing Red).
   D. Close the Beam Port by holding the Beam Port Switch until the Green (closed) light comes on. Reset the annunciator and observe that the light goes out.
   E. Announce over the Building PA "Beam Port secured". Complete SOP 810.
   F. Dispatch a knowledgeable individual to the Thermal Column with the Thermal Column Key. Select the Basement Level Station on the Building Intercom.
   G. Address the operator over the intercom to open the Thermal Column until the warning light comes on (approximately 1 inch).

H. The Control Room Operator should observe and acknowledge the annunciator alarm. Inform the Thermal Column Operator to shut the Thermal Column and ensure the warning light goes off.

I. Reset the annunciator and have the Thermal Column Operator return the key to the locker. Complete form SOP 810. |Rev.

10. SHUTDOWN CHECK:

A. Complete a Shutdown Check List form 103 to ensure that all console equipment is secured.

11. SECURITY SYSTEM:

Inform the campus police (4300) that the security system will be checked. Del.

1. Security Door
   a. Have police remain on line for the security checks.
   b. Hold in or close dead bolt on the security door.
   c. Reset the alarm system.
   d. Open dead bolt switch by releasing or opening dead bolt and ensure alarm occurs in campus police dispatch station.

2. Ultrasonics
   a. Hold or close dead bolt on security door. Reset alarm system.
   b. While holding the dead bolt switch, move around or have someone walk toward one of the UT's. Have campus police notify you when the alarm occurs. A different ultra sonic detector should be tested each week.
   c. Allow the ultrasonic to reset by moving clear of the detector or stand still.

3. Duress
   a. Inform the campus police that the duress alarm will be tested.

b. Momentarily depress the alarm button. The campus police should indicate the satisfactory operation of this alarm.

4. Doors
   a. While holding the dead bolt switch closed, reset the alarm.

   b. Open one of the exterior doors equipped with an intrusion alarm. A different door should be tested each week.
   c. Have the campus police acknowledge the alarm when the door is opened. Rev.
   d. Repeat steps a, b, and c for one of the interior doors equipped with an intrusion alarm. A different door should be tested each week.
   e. When all intrusion channels have been tested, ask campus police to check the battery circuit. This completes the security check. Rev.
   f. When all channels of the security system have been functionally tested and operate properly, initial the weekly checklist, Form SOP 810. Del.

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Date Performed ____________________

1. ROD PROHIBIT

	Annunciator	Prohibit	Initial
A. Recorder Off			
(1) Log count rate recorder	________	________	________
(2) Linear recorder	________	________	________
(3) Period recorder	________	________	________
(4) Log N recorder	________	________	________
(5) Temperature recorder	________	________	________

B. Log count rate <2CPS

	Actual Trip Point	Annunciator	Prohibit	Initial
B. Log count rate <2CPS	________	________	________	________
C. Period <30 seconds	________	________	________	________
D. Inlet Temperature >135^{o}F	________	________	________	________
E. Shim Rods below shim range			________	________

2. RUNDOWN CHECK

A. RAM System

Station	Bldg. Alarm	Remote and Local Alarm	Annunciator	Rundown	Trip point	Initial
1.	________	________			________	________
1.		________	________	________	________	________
2.		________	________	________	________	________
3.		________	________	________	________	________

	Actual Trip Point	Annunciator	Rundown	Initial
B. 120% Demand rundown	________	________	________	________
C. Period 15 seconds rundown	________	________	________	________

Written By: Carl Barton Approved By: Albert Bolon

Date ______________________

D. 120% Full Power Rundown

	Actual Trip Point	Annunciator	Rundown	Initial
D. 120% Full Power Rundown	________	________	________	________
E. Low CIC Linear P S.	________	________	________	________
F. Low CIC Log N P.S.	________	________	________	________
G. Regulating Rod on Insert Limit on Auto		________	________	________

3. SCRAM CHECK

	Actual Trip Point	Annunciator	Scram	Initial
A. Bridge Motion Scram		________	________	________
B. Period <5 Seconds Scram	________	________	________	________
C. Log N Period Non-operative Scram		________	________	________
D. 150% Full Power Scram		________	________	________
E. Manual Scram		________	________	________

4. ROD DROP CURRENTS

	Drop Current	Contact Light Off	Initial
A. Rod #1	________	________	________
B. Rod #2	________	________	________
C. Rod #3	________	________	________

5. TEST OF ANNUNCIATORS

A. Beam Room High Neutron Flux

Local Alarm Light	Annunciator	Initial
________	________	________

Written By: Carl Barton

Approved By: Albert Bolon

Date ____________________

B. Interlock Bypass

	Annunciator	Initial
(1) Shim range	________	______
(2) 30 second period	________	______
(3) Radiation area high	________	______
(4) <2 CPS	________	______

C. Servo Limits

Lin. Rec. Reading	Permit on at	Permit off at	Initial
__________%	________%	________	______

D. Pool Demineralizer Effluent Conductivity High

Local Alarm	Annunciator	Initial
________	________	______

6. "REACTOR ON" LIGHTS

	Operational	Initial
A. Main Entrance	________	______
B. Control Room	________	______
C. Beam Room	________	______

7. BUILDING EVACUATION

Alarm Operational	Initial
________	______

8. NITROGEN DIFFUSER

	Pump Operational	Indicator Light On	Initial
A. #1	________	________	______
B. #2	________	________	______

9. BEAM PORT AND THERMAL COLUMN WARNING LIGHT

	Annunciator	Flashing Light	Initial
A. Beam Port	________	________	______
B. Thermal Column	________	________	______

10. SHUT DOWN CHECK LIST

Completed	Initial
________	______

11. SECURITY SYSTEM

Battery Check		Initial
________	________	______

12. APPROVED AND REVIEWED ______________________________
Manager or Director (Rev. 8/90)

Written By: Carl Barton

Approved By: Albert Bolon