University of Missouri-Rolla
*Nuclear Reactor Facility*

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April 19, 2000

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

Dear Sir:

Please find enclosed the Annual Progress Report 1999-2000 for the University of Missouri-Rolla Reactor Facility (License R-79). This report is being filed under the reporting requirements of our Technical Specifications. Copies of this report are also being sent to our Regional Administrator and Project Manager.

Sincerely,

Dr. Nicholas Tsoulfanidis
Interim Reactor Director

mk

Enclosure

xc: Marvin Mendonca, Project Manager (NRC)
Dr. John Park, Chancellor (UMR)
Dr. Lee W. Saperstein, Dean, School of Mines & Metallurgy (UMR)
Mr. Ray Bono, Director, Health & Safety Services (UMR)
Dr. Nicholas Tsoulfanidis, Radiation Safety Officer (UMR)
Dr. Robert Mitchell, Dean, School of Engineering (UMR)
Dr. Russell Buhite, Dean, College of Arts and Science (UMR)
Mr. Bruce Ernst, American Nuclear Insurers
American Nuclear Insurers, c/o Librarian
Dr. Mark Fitch, Chairman, Radiation Safety Committee (UMR)
University of Missouri-Columbia Research Reactor

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# PROGRESS REPORT

# 1999-2000

# UNIVERSITY OF MISSOURI-ROLLA

# NUCLEAR REACTOR FACILITY

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# UNIVERSITY OF MISSOURI-ROLLA

# NUCLEAR REACTOR FACILITY

# PROGRESS REPORT

# FOR THE

# UNIVERSITY OF MISSOURI-ROLLA

# NUCLEAR REACTOR FACILITY

April 1, 1999 to March 31, 2000

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

## SUMMARY

During the 1999-2000 reporting period the University of Missouri-Rolla Reactor (UMRR) was in use for 400 hours. The major part of this time, about 95% was used for class instruction, research, and training purposes.

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

The reactor facility supported several UMR courses over the year for a total of 2,959 student-hours. The reactor was visited by about 3,091 visitors during the past year. There were 942 participants, mostly high school students, in the U.S. Department of Energy Reactor Sharing Program.

The reactor produced 7,320 kilowatt-hours of thermal energy using approximately 0.44 grams of uranium. A total of 190 samples were irradiated in the reactor with most of them being analyzed in the Reactor Counting Laboratory.

**Table of Contents**

## List of Tables



## List of Figures

# 1.0 INTRODUCTION

This progress report covers activities at the University of Missouri-Rolla Reactor (UMRR) Facility for the period April 1, 1999 to March 31, 2000.

The reactor is operated as a university facility, available to the faculty and students from various departments of the university for their educational and research programs. Several other college and pre-college institutions have made use of the facility during the reporting period. The facility is also available for the training of reactor personnel from nuclear electric utilities.

## 1.1 Background Information

The University of Missouri-Rolla Reactor Facility attained initial criticality on December 9th, 1961. The UMRR was the first operating nuclear reactor in the state of Missouri. The reactor design is based on the Bulk Shielding Reactor at Oak Ridge National Laboratory. The reactor is a light water open pool reactor cooled by natural convection flow. The fuel is MTR plate-type fuel. The initial licensed power was 10 kW. The licensed power was upgraded to 200 kW in 1966. During the summer of 1992, the reactor fuel was converted from high-enriched uranium fuel to low-enriched uranium.

The facility is equipped with several experimental facilities including a beam port, thermal column, pneumatic rabbit system and several manual sample irradiation facilities. Additionally, the facility is equipped with a counting laboratory that has gamma and alpha spectroscopy capabilities. The gamma spectroscopy system includes germanium and sodium-iodide detectors, associated electronics, and state-of-the-art data acquisition and spectrum analysis software. The alpha spectroscopy system consists of a surface barrier detector and data acquisition equipment. The beamport experimental area is equipped with NE-213 and time-of-flight neutron spectroscopy systems.

1.2 General Facility Status

The UMRR operated safely and efficiently over the past year. No significant safety-related incidents or personnel exposures occurred. On January 6, 2000, Dr. David Freeman, who had been serving as Reactor Director resigned and now teaches Nuclear Engineering at Kansas State University. Dr. Nicholas Tsoulfanidis serves as Interim Reactor Director. The Reactor Manager position has been reinstated. This change has been reviewed and approved by NRC. SAR pages describing the administrative structure have been revised and are presented in Appendix A. William Bonzer serves as Interim Reactor Manager.

The license for UMRR has been extended to January 14, 2005, Amendment No. 16 (August 6, 1999). We have been working on relicensing during this period and will continue.

We are continuing efforts to upgrade our console using grant awards from DOE combined with money directly from reactor funds. We received an additional grant for instrumentation funding in the summer of 1999 and have recently received verbal notice of instrumentation grant award for the Spring of 2000.

We have purchased three new instrument drawers from Gamma-Metrics including 1) a wide-range log fission chamber based drawer, 2) a wide-range linear CIC based drawer, and 3) a log and linear CIC based drawer. We plan to install these three drawers in our control console as direct replacements for our existing Start-up, Log N and Period, and Linear drawers under the provisions of 10CFR50.59.

We have purchased a demineralizer tank, resins and conductivity analyzer for replacement of our existing system. The replacement is near completion as of the end of this reporting period under the provisions of 10CFR50.59.

Graduate research aimed at characterizing pool water temperature profiles has continued this year and utilizes newly acquired computer data acquisition equipment coupled with several temperature sensors. This research will lead to improved power measurements and live time reactor power measurements. The work has been funded from reactor accounts and has resulted in a Master's thesis (May, 1999).

The reactor is currently funding a graduate student to perform research in support of the relicensing effort. To date this research has focused on atmospheric dispersion modeling and dose assessments associated with normal operations and accident conditions.

The Reactor Facility was audited by an independent auditor from the University of Columbia on August 25, 1999. There were no significant areas of concern. We have entered into an agreement with both the University of Illinois and the University of Missouri-Columbia to rotate audits. This has been a very beneficial arrangement for all facilities involved.

The reactor staff has continued to review the operation of the Reactor Facility in an effort to improve the safety and efficiency of its operation and to provide conditions conducive to its utilization by students and faculty. An "outreach" program, implemented over the past years, has been continued in order to let both students and faculty in a number of departments across campus know how the reactor could be used to enhance course work and research. As a result, additional classes have been using the Reactor Facility to augment their programs, including Physics 4 & 5, "Concepts in Physics"; Physics 7, "Environmental Physics"; Chemistry 8, "Qualitative Analysis Laboratory"; Physics 107, "Modern Physics"; Physics 207 “Modern Physics II, Physics 322, "Advanced Physics"; Chemical Engineering 261, "Introduction to Environmental Engineering"; Chemistry 2, "General Chemistry Laboratory"; Mechanical Engineering 229, "Energy Conversion"; Life Science 352, "Biological Effects of Radiation"; Chemistry 251, "Intermediate Quantitative Analysis"; Chemistry 355, "Instrumental Methods Laboratory"; Civil Engineering 310, “Senior Design Class”, Basic Engineering 50, “Engineering Mechanics - Statics”, and Engineering Management 386, "Safety Engineering Management".

SOPs have been revised over the past year in order to improve our operations and efficiency. The following is a list of SOPs revised during the reporting period:

| | |
|---|---|
| SOP 102 | Pre-Startup Checklist Procedure (Page 3 and 7) |
| SOP 106 | Permanent Log, Hourly Log and Operational Data (Page 6) |
| SOP 204 | Demineralizer Regeneration (Page 1) |
| SOP 501 | Emergency Procedures For Reactor Building Evacuation (Page 7) |
| SOP 507 | Emergency Procedures-Administrative Responsibilities (Page 2) |
| SOP 508 | Tornado Threat (Page 1) |
| SOP 621 | Guidelines For Emergency Exposures (Pages 2 and 3) |
| SOP 654 | Measurement of $^{41}Ar$ Concentration In The Reactor Building Air (Page 2) |
| SOP 655 | Radiation Area Monitor (RAM) Calibrations (Pages 3 and 4) |
| SOP 701 | Request For Reactor Projects (Page 1) |
| SOP 711 | Standard Operating Procedures (Page 2) |
| SOP 712 | Standard Operating Procedures (Page 1) |
| SOP 800 | Semi-Annual Checklist (Page 5) |
| SOP 803 | Log Count Rate (LCR) Channel |

The above listed SOP revisions are provided in Appendix B.

# 2.0 REACTOR STAFF AND PERSONNEL

## 2.1 Reactor Staff

| **Name** | **Title** |
|---|---|
| Dr. David Freeman [1)] | Director |
| Dr. Nicholas Tsoulfanidis [2)] | Interim Director |
| Mendy Kell | Senior Secretary |
| William Bonzer [3)] | Senior Electronics Technician and Interim Manager |
| James Jackson | Senior Lab Mechanic |

[1)] Terminated effective January 6, 2000
[2)] Interim Director effective January 6, 2000
[3)] Interim Manager effective January 6, 2000

## 2.2 Licensed Operators

| **Name** | **License** |
|---|---|
| David Freeman [1)] | Senior Operator |
| William Bonzer | Senior Operator |
| James Jackson | Reactor Operator |
| Albert E. Bolon (Inactive) | Senior Operator |

[1)] License terminated as of February 2, 2000

## 2.3 Radiation Safety Committee

The Radiation Safety Committee meets quarterly. The committee met on 6/15/99, 9/07/99, 12/17/99, and 3/20/2000 during the reporting period. The committee members are listed below.

| **Name** | **Department** |
|---|---|
| Dr. Mark Fitch, (Chairman) | Civil Engineering |
| Mr. Ray Bono (Secretary, ex-officio, non-voting) | Occupational Health and Safety Services |
| Mr. David Freeman[1)] | Nuclear Reactor |
| Dr. Nord L. Gale | Life Sciences |
| Dr. Edward Hale[2)] | Physics |
| Dr. Arvind Kumar | Nuclear Engineering |
| Dr. Oliver K. Manuel | Chemistry |
| Mr. Randy Stoll | Director, Business Services |
| Dr. Nick Tsoulfanidis | Nuclear Engineering |
| Dr. Robert DuBois[3)] | Physics |

[1)] Terminated effective January 6, 2000; replaced by William Bonzer.
[2)] Resigned effective February 29, 2000; has been replaced by Dr. DuBois.
[3)] Effective February 29, 2000.

## 2.4 Health Physics

Health Physics support is provided through the Occupational Health and Safety Services Department which is organizationally independent of the Reactor Facility operations group. Health Physics personnel are listed below:

| **Name** | **Title** |
| --- | --- |
| Dr. Nick Tsoulfanidis | Radiation Safety Officer |
| Mr. Ray Bono | Director, Occupational Health & Safety Services and Campus Health Physicist |
| Mr. Brian Smith | Safety Specialist |
| Rachel Ragland[1)] | HP Technician |
| Kasi Johnson[2)] | HP Technician |
| Micah Hackett | HP Technician |
| Heather Nydeger[3)] | HP Technician |
| Gary Wilburn[4)] | HP Technician |

[1)]Terminated effective 5/04/99.
[2)]Terminated effective 9/23/99.
[3)]Employed effective 8/23/99.
[4)]Employed effective 04/12/99.

## 3.0 REACTOR OPERATIONS

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

Table 3-1 presents pertinent core data and Figure 3-1 shows the core configuration of core 101W. The excess reactivity, shutdown margin, and rod worths were measured in cold, clean conditions.

**Table 3-1. Core 101W Technical Data**

| Parameter | Value |
|---|---|
| Rod 1 | 2.73% Δk/k |
| Rod 2 | 2.69% Δk/k |
| Rod 3 | 3.22% Δk/k |
| Reg Rod | 0.371% Δk/k |
| Excess Reactivity | 0.496% Δk/k |
| Shutdown Margin* | 4.92% Δk/k |

* Assumes Rod 3 (highest worth rod) and Reg Rod are fully withdrawn.

Table 3-2 presents a listing of unscheduled shutdowns (scrams, rundowns, and unplanned normal shutdowns) along with their causes and corrective actions. There were two unscheduled scrams. Both scrams were caused by noise spikes within the safety channel/magnet drawer. The drawer was repaired and we are in the process of purchasing replacement drawers for the safety channels and magnet power supply. Four of the six rundowns listed were due to noise sensitivity of our new Gamma Metrics Wide Range Log drawer. The drawer appears to be especially

**Figure 3-1. UMRR Core 101W Configuration**

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

<u>KEY TO PREFIXES</u>

F - Standard Elements

C - Control Elements

BR - Bare Rabbit

CR - Cadmium Rabbit

S - Source Holder

sensitive to switching noise when the reactor is at or near full power. Switching associated with the auto controller and rod movements can induce enough noise to trip the 120% Full Power rundown. We have worked with Gamma Metrics to resolve the situation. Gamma Metrics supplied us with a replacement AC filter; however, that did not change our situation. We are continuing to work with Gamma Metrics to resolve the problem.

Since the 120% Full Power trip is set on the log power signal, the voltage change between 100% and 120% on an eight decade scale is very small. In the future we may argue that it is inappropriate to have a 120% trip on a logarithmic power channel and seek to change that particular technical specification. Although this situation is not considered a safety problem, we are committed to continue efforts to resolve the matter in a timely fashion.

Maintenance activities are listed in Table 3-3. Table 3-4 shows reactor utilization and Table 3-5 shows other facility usage.

**Table 3-2. Scrams, Rundowns, and Unplanned Shutdowns**

| **Date** | **Cause** |
|---|---|
| 4/20/99 | Reactor Rundown. 120% Full Power Rundown. Reactor at 100% full Power. Trip occurred when acknowledging the annunciator.<br>Cause: Spurious noise signal from acknowledge switch activated the 120% Full Power trip.<br>Corrective Action: No corrective action necessary. SRO on duty granted permission to restart. |
| 9/22/99 | Reactor Scram. Reactor power at 10W<br>Cause: Unknown cause, no alarms.<br>Corrective Action: Decided a noise spike in magnet power supply could create the scram. No corrective action taken. SRO on Duty granted permission to restart. |

**Table 3-2 cont'd.**

| | |
|---|---|
| 09/30/99 | Reactor Rundown. 120% Demand Rundown.<br>Cause: Linear Recorder had noise spikes that activated the rundown trip.<br>Corrective Action: Replaced recorder input connector and vacuum tubes. SRO on Duty granted permission to restart. |
| 11/04/99 | Reactor Rundown. 120% Demand Rundown.<br>Cause: Operator did not upscale when starting power increase.<br>Corrective Action: Operator was instructed to upscale as procedures require. SRO on Duty granted permission to restart. |
| 02/24/00 | Reactor Scram. 150% Full Power Scram.<br>Cause: Reactor power at 10W. Noise spike occurred in Safety Channel #1.<br>Corrective Action: Replaced signal cable from reactor bridge to Safety Channel preamp #1. SRO on Duty granted permission to restart. |
| 03/20/00 | Reactor Rundown. 120% Full Power Rundown.<br>Cause: Three individual 120% Full Power rundowns occurred while stabilizing reactor power at 200kW. Each rundown was cause by a noise spike. Annunciator switch and rod movements created the noise spikes. The reactor was less than or at 100% full power for each rundown.<br>No corrective action necessary. SRO on Duty granted permission to restart reactor. |

**Table 3-3. Maintenance**

| Date | Cause |
|---|---|
| 06/07/99 | Problem: Routine semi-annual Calibration and preventive maintenance.<br>Corrective Action: Repositioned the Safety Channels UIC#1 and UIC#2 and the Log and Linear Channel CIC for proper calibration after the thermal power calibration. |
| 06/29/99 | Problem: Performed routine visual rod inspection.<br>Corrective Action: Unloaded reactor core, removed control rod drive shrouds and magnets. Removed control rods and visually inspected them. Installed control rods, magnets, control rod drive shrouds and fuel elements. Performed control rod drop time tests. The visual rod inspections and rod drop time tests passed technical specification limits. |
| 08/17/99 | Problem: AC Regulator is not stable at 120VA.<br>Corrective Action: Replaced the AC Regulator with a Line Conditioner. |

**Table 3-3 cont'd.**

| | |
|---|---|
| 08/24/99 | Problem: Magnet extension tube upper connector is worn.<br>Corrective Action: Replaced the upper connector for magnet extension tube #3. Performed rod drop time measurement test for magnet #3. |
| 08/27/99 | Problem: Magnet #2 power supply current read above 100mA and could not adjust to lower current.<br>Corrective Action: Replaced vacuum tube in Magnet #2 power supply. |
| 10/04/99 | Problem: Noise spikes on Linear Recorder.<br>Corrective Action: Replaced amplifier in the Linear Recorder. Performed a calibration check on the Linear Recorder |
| 10/07/99 | Problem: Magnet #3 would not hold the control rod.<br>Corrective Action: Replaced Magnet #3 in the pool. Performed rod drop time test for control rod #3. |
| 10/15/99 | Problem: Regulating Rod would not rundown when the operate/shutdown switch was repositioned to operate.<br>Corrective Action: Replaced the rod rundown relay for the regulating rod. |
| 10/15/99 | Problem: Magnet #3 would not hold the control rod.<br>Corrective Action: Replaced Magnet #3 in the pool. Performed rod drop time test for control rod #3. |
| 01/06/00 | Problem: Routine Semi-Annual Calibration and preventive maintenance.<br>Corrective Action: Calibration performed. Repositioned Safety Channels UIC #1 and UIC#2 for proper calibration after thermal power calibration. |
| 02/01/00 | Problem: Safety Channel #2 meter reading was abnormal during prestart-up scram test.<br>Corrective Action: Cleaned meter lens with anti-static solution to remove static charge on meter lens. |
| 03/04/00 | Problem: Safety Channel #1 displays noise spikes on meter.<br>Corrective Action: Replaced diode in Safety Channel drawer. |

**Table 3-4. Reactor Utilization**

| | | |
|---|---|---|
| 1. | Reactor use | 400 hrs. |
| | a. NE Classes, Reactor Sharing, and Other Instructions | 346 hrs. |
| | b. Maintenance Training | 39 hrs. |
| 2. | Time at power | 180 hrs. |
| 3. | Energy generated | 7320 kW/hrs |
| 4. | Total number of samples | 190 |
| 5. | U-235 Burned | 0.442058 g |
| 6. | U-235 Burned and Converted | 0.523264 g |

**Table 3-5. Experimental Facility Use Other Than The Reactor**

| Facility | Hours |
|---|---|
| Bare Rabbit Tube | 4.57 hr. |
| Cadmium Rabbit Tube | 0.00 hr. |
| Beam Port | 1.47 hr. |
| Other Core Positions | .66 hr. |
| Total | 6.7 hr. |

## 4.0 PUBLIC RELATIONS

The reactor staff continues to educate the public about applications of nuclear science. Over 3,091 persons visited the facility during this reporting period. Tour groups are typically given a brief orientation and/or demonstration by a member of the reactor staff.

Table 4-1 lists some of the major occasions or groups and number of visitors for each event.

| Table 4-1. Public Relations Program | | |
|---|---|---|
| DATE | PARTICIPANTS | NUMBER |
| 4/5/99&2/19/00 | Rolla Area Boy Scouts | 44 |
| 05/15/99 | UMR Graduation "Blue Glow" Tour | 33 |
| 06/07-08/09/99 | UMR Jackling Institute | 171 |
| 06/14/99 | UMR Chemistry Academy | 39 |
| 06/16/99 | UMR Introduction to Engineering | 172 |
| 07/14/99 | UMR Space Camp | 173 |
| 09/27-9/30/99 | UMR Blue Glow Tour for Chemistry Students | 38 |
| 10/22/99 | UMR Scholars Weekend Open House | 14 |
| 10/23/99 | UMR Fall Open House | 45 |
| 08/30-9/01/99 | Abtelung Julich, Germany University | 10 |
| 09/27/99 | UMR Offsite Emergency Training | 14 |
| 02/10/00 | UMR Basic Engineering TEAMS Competition | 48 |
| 02/15/99 | UMR President's Day Open House | 79 |
| 02/21/00 | UMR Miner Monday Open Houses | 8 |
| 03/03/00 | UMR Occupational Health & Safety Services Safety Meeting | 14 |
| 03/26/00 | Missouri Area Chamber of Commerce | 30 |

## 5.0 EDUCATIONAL UTILIZATION

The reactor facility supported several UMR courses in the past year for a total of 2,959 student-hours. The number of UMR students utilizing the facility was 879. This usage is a direct result of an aggressive and continuing campus wide "outreach" program. The reactor facility provided financial support for five students with hourly wages, and two Graduate Research Assistants. Additionally, students from several universities, colleges and high schools have used the facility.

Table 5-1 lists UMR classes taught at the facility along with associated reactor usage for this reporting period.

The University of Missouri-Columbia Nuclear Engineering Department will be sending its NE 404, "Advanced Reactor Laboratory" class to our facility twice during April, 2000, (for a total of 12 hours) to participate in a wide variety of reactor experiments that they are unable to perform with their reactor. The laboratories are held in the evening (4:00 pm until 10:00 pm) and are conducted by the UMR reactor staff.

The Reactor Sharing Program, which is funded by the U.S. Department of Energy, was established for colleges, universities, and high schools which do not have a nuclear reactor. This year, 942 students and instructors from 42 institutions participated in the program. Table 5-2 lists those schools and groups that were involved in this year's Reactor Sharing Program. The majority of our participants were high school students. We coordinate with the Admissions Office to schedule high school students to see other items of interest at UMR after they have visited our facility, such as the student group of American Nuclear Society, the Computer Integrated Manufacturing Lab, the Foundry, Ceramics Engineering, Mineral Museum, Computer Center, Experimental Mine, Solar Car, Electron Microscope, and Stonehenge. The Reactor Sharing Program serves as a strong campus-wide recruiting tool by getting high school students to the university and hopefully sparking some interest in our campus.

**Table 5-1. UMR Classes at Reactor Facility**
**1999-2000 Reporting Period**

| | CLASS NUMBER/TITLE | # OF STUDENTS | TIME AT REACTOR | STUDENT HOURS |
|---|---|---|---|---|
| 04/20/99 | UMR NE 204 - Radiation Measurements | 5 | 3.00 | 15.00 |
| 04/22/99 | UMR NE 204 - Radiation Measurements | 5 | 2.50 | 12.50 |
| 04/29/99 | UMR NE 204 - Radiation Measurements | 5 | 2.50 | 12.50 |
| 05/07/99 | UMR Physics 107, Modern Physics | 17 | 1.00 | 17.00 |
| Fall 1999 | UMR NE 304, Reactor Laboratory I | 6 | 30.00 | 180.00 |
| Fall 1999 | UMR NE 306, Reactor Operations | 4 | 36.00 | 144.00 |
| Fall 1999 | UMR NE 490, Research (Eric Stevenson - Thermal Power Cal. | 1 | 320.00 | 320.00 |
| Fall 1999 | UMR NE 490, Research (Scott Gizzie - Relicensing) | 1 | 320.00 | 320.00 |
| Fall 1999 | UMR NE 490, Research (Matt Adler-Safety Analysis of UMR Rx | 1 | 320.00 | 320.00 |
| Fall 1999 | UMR 490, Research (Bill Dennis, Geology, Lake sediment, sample | 1 | 45.00 | 45.00 |
| Winter 2000 | UMR NE 306, Reactor Operations | 6 | 36.00 | 216.00 |
| Winter 2000 | UMR NE 308, Reactor Laboratory II | 7 | 80.00 | 560.00 |
| Winter 2000 | UMR NE 490, Research (Matt Adler-Safety Analysis of UMR Rx | 1 | 320.00 | 320.00 |
| Winter 2000 | UMR 490, Research (Ellen England, Filtration of Contam. Water | 1 | 25.00 | 25.00 |
| 9/27-9/30/99 | UMR Chemistry Labs | 465 | 050 | 232.50 |
| 10/04/99 | UMR Chemistry Labs | 39 | 0.50 | 19.50 |
| 02/10/00 | UMR Chemistry Labs | 71 | 0.50 | 35.50 |
| 02/10/00 | UMR Chemistry Labs | 16 | 0.50 | 8.00 |
| 11/23/99 | UMR Environmental Physics 6 | 12 | 1.00 | 12.00 |
| 06/16/99 | UMR Basic Engineering 50 | 45 | 0.50 | 22.50 |
| 07/15/00 | UMR Basic Engineering 50 | 66 | 0.50 | 33.00 |
| 07/22/00 | UMR Basic Engineering 50 | 61 | 0.50 | 30.50 |
| 08/24/99 | UMR Civil Enineering Senior Design Class | 24 | 1.50 | 36.00 |
| | UMR NE 25-Nuclear Technology Applications | 8 | 1.45 | 11.60 |
| | UMR Physics 7 | 11 | 1.00 | 11.00 |
| 01/13/00 | UMR NE 204 - Radiation Measurements | 12 | 2.00 | 24.00 |
| | **Totals** | **879** | **1549.45** | **2959.10** |

| | Table 5-2. Reactor Sharing Program (1999-2000) | |
|---|---|---|
| **DATE** | **PARTICIPANTS** | **NUMBER** |
| 04/01/99 | Southwest Missouri State University, Dr. Robert Mayanovic, Instructor | 6 |
| 04/06/99 | Crossroads High School, Tanda Pommier, Instructor | 35 |
| 04/14/99 | Marion C. Early High School, Shannon Snow, Instructor | 18 |
| 04/14/99 | St. James High School, Jim Jenkins, Instructor | 15 |
| 04/21/99 | Whitfield High School, Tom Rodgers, Instructor | 66 |
| 04/29/99 | Willow Springs 6th Graders, Jeanette Ronse, Instructor | 19 |
| 05/04/99 | Vienna Catholic School, (Admissions arranged) | 10 |
| 05/05/99 | Northwest High School, Nancy Farr, Instructor | 81 |
| 05/07/99 | Hillcrest High School, (Admissions arranged) | 7 |
| 05/18/99 | Columbia Hickman High School, Polly Hendren | 14 |
| 05/21/99 | Turner Middle School (Admissions arranged) | 28 |
| 05/21/99 | Parkway North Middle School, (Admissions arranged) | 25 |
| 09/23/99 | Compton-Drew ILC Middle School | 46 |
| 10/07/99 | St. Charles-West High School, Rebecca Teague, Instructor | 42 |
| 10/21/99 | Sullivan High School, David Miller, Instructor | 9 |
| 10/27/99 | Steelville High School, Charles Hawkins, Instructor | 15 |
| 10/28/99 | East Central College, Laura Deason, Instructor | 12 |
| 10/29/99 | Neosho/Crowder College, (Admissions arranged) | 3 |
| 11/04/99 | Mansfield High School, Pam Probert, Instructor | 30 |
| 11/09/99 | Summersville High School, Joni Appleton, Instructor | 30 |
| 11/10/99 | Ash Grove High School, Sally Keith, Instructor | 17 |
| 11/10/99 | Salem Green Forest, (Admissions arranged) | 55 |
| 11/11/99 | St. Elizabeth High School, Janice Weiberg, Instructor | 15 |
| 11/11/99 | Cole County R-V School, Eugene, MO, Doug Farris, Instructor | 9 |
| 11/16/99 | Nixa High School, Laura Pendergrass, Instructor | 38 |
| 11/17/99 | Marquette High School, Phil Schmidt, Instructor | 30 |
| 11/18/99 | Perryville High School, Wendy O'Neal, Instructor | 25 |
| 12/08/99 | Concordia High School, (Admissions arranged) | 12 |
| 02/15/00 | Thomas Jefferson High School, Kathy Weibrecht, Instructor | 20 |
| 02/16/00 | Logan-Rogersville Junior High School, (Admissions arranged) | 16 |
| 02/22/00 | Lebanon High School, John Sode, Instructor | 36 |
| 03/09/00 | Rolla High School, Erin Mulanax, Instructor | 40 |
| 03/09/00 | Rolla Middle School, Science Club, Jane Haskell, Instructor | 25 |
| 03/21/00 | Climax Springs High School, Karen Foote, Instructor | 10 |
| 03/22/00 | Hazelwood West High School, Gail Haynes, Instructor | 21 |
| 03/29/00 | Washington High School, (Admissions arranged) | 46 |
| | Andy Ramakrishna, Individual Science Project, Jefferson City High School | 1 |
| | Laura Richeson, Individual Science Project, Potosi High School, Bill Nelson | 1 |
| | Cassie Avila, Individual Science Project, Potosi High School, Bill Nelson | 1 |
| | Karla White, Individual Science Project, Potosi High School, Bill Nelson | 1 |
| | Rebecca Moneymaker, Individual Science Project, Newburg High School | 1 |
| | Rebecca Adams, Individual Science Project, St. James High School | 1 |
| | TOTAL | **942** |

# 6.0 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.

## 6.1. Routine Surveys

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

## 6.2. By-Product Material Release Surveys

There was a shipment of by-product material released on-campus from the reactor facility during this reporting period. The materials shipped consisted of Pool Water Filters, Demineralizer Tank, Demineralizer Resins, 60 lb. of gloves, plastic bags, dirt and paper towels.

## 6.3. Routine Monitoring

Twenty-nine reactor facility personnel and students involved with operations in the reactor facility are currently assigned film badges. Three are read twice per month (Reactor Staff) and twenty-six are read once per month. There are four area beta-gamma/neutron badges assigned. Twenty-six 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 20 area monitor and 1 spare badge assigned on campus. In addition, 5 digital direct-reading dosimeters, 4 chirpers, and 6 ion-chamber 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 millirem.

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

Pool water activity is monitored monthly to ensure that no gross pool contamination or fuel cladding rupture has occurred. Gross counts and spectra of long-lived gamma activity are compared to previous monthly counts. From April 1999 through March 2000 sample concentrations averaged $4.6 \times 10^{-7}$ μCi/ml.

Release of gaseous Ar-41 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, an estimated 45.97 millicuries of Ar-41 was released into the air.

6.4. Waste Disposal

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. Water is analyzed for radioactive contamination and approval is required before the water is released. During this period 1,610 pounds of waste consisting of Demineralizer tank and resins, regeneration filters and laboratory waste containing trace amounts of Co-60 and Cs-137 was transferred from the Reactor Facility to the Dangerous Material Storage Facility.

6.5. Instrument Calibrations

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

## 7.0 PLANS

The reactor staff will be heavily involved in four major projects during the next reporting period; 1) Administrative changes 2) relicensing 3) implementation and revision of the new strategic plan, 4) installing new reactor nuclear instrumentation.

7.1 Administrative Changes

The Interim Director and Manager positions will be made permanent during the year. As of now the reactor staff has been reduced by 25% as we are filling these positions with permanent employees. Reactor operations continue to proceed but strain the capacity to perform projects that required a full staff.

7.2. Relicensing

Relicensing activities will continue during the upcoming reporting period. Our present license has been extended and is valid until January, 2005. Emphasis will be directed toward the SAR accident scenarios and Emergency Plan.

7.3. Strategic Plan

A strategic plan has been developed to help the facility achieve its vision "to become nationally recognized as the leading educational and training university reactor in the country and to become recognized as the leading 200 kW facility in terms of research". The strategic plan identifies strategic goals and action items. The action items will be initiated over the coming year and will guide the facility towards its vision.

7.4. Instrumentation Upgrade

The reactor console upgrade is well underway. Several pieces of new equipment have been installed under the provisions of 10 CFR Part 50.59. We plan to install a new Linear drawer, Source Range drawer and a new annunciator panel during the upcoming reporting period. Most of the changes will be made under the provisions of 50.59 ; however, some changes may require NRC approval.

APPENDIX A.

REVISED SAR PAGE 8-2

FOR THE 1999-2000 REPORTING YEAR

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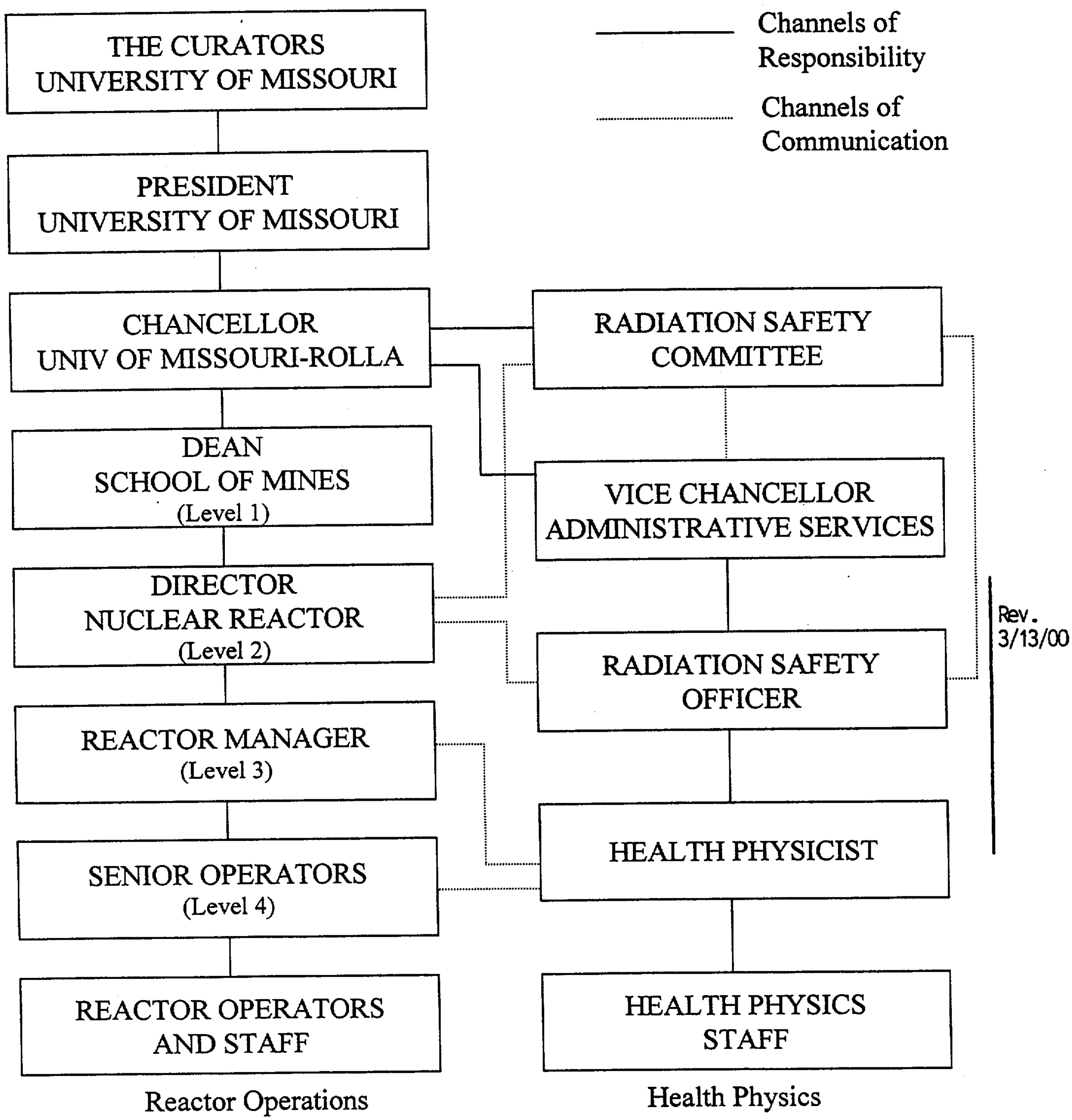


Figure 25 Organizational structure of the University of Missouri related to the UMR Nuclear Reactor Facility.

APPENDIX B.

STANDARD OPERATING PROCEDURES

CHANGED DURING THE 1999-2000

REPORTING YEAR

10. **Linear CIC Voltage:** Record the high voltage (HV) and compensating voltage (CV) settings of the Linear power supply. Values should correspond approximately to the following:

    HV ~ 540 VDC
    CV ~ 2 to 8 VDC

11. a. Observe the temperature and CAM recorder "RCD" is illuminated in the upper left hand corner of the display. Rev.
    b. Turn on and date the Startup, Linear, and Log/Period recorders. Reset the annunciator panel.

12. **Core Check:** Turn the pool lights on.

    a. Check the water level in the pool.
    b. Visually inspect the core and pool for abnormalities. Check in-core experiments.
    c. Insert the source into the core source holder.

13. **Start-Up Channel Test:** Turn the Log Count Rate selector switch to $10^2$, $10^3$, and $10^4$. Verify that the meter and recorder follow. Return the selector switch to the "OPERATE" position.

14. **Verify Fission Chamber Response:** Insert the fission chamber until the green Insert Limit light comes on. Observe the count rate. Raise the fission chamber until the count rate shows a definite decrease. Verify that the 2 cps alarm trips at a count rate greater than or equal to 2 cps. Insert the fission chamber to insert limit. Verify that the count rate is greater than 2 cps. (Following a high power run, the SRO on Duty may position the fission chamber as desired as long as a count rate greater than 2 cps is maintained.)

15. Observe the Log Count Rate H.V. power supply setting is positive 400 VDC. If setting is different then notify the SRO on Duty.

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| | | | | | |
|---|---|---|---|---|---|
| 1. Date | | | | | |
| 2. Initials of the Person Performing Checklist | | | | | |
| 3. Time (Console Clock) | | | | | |
| 4. Core Loading | | | | | |
| 5. P.A., Intercom, Video Monitor On | | | | | |
| 6. RAM System Check | | | | | |
| 7. Radiation Level Normal | | | | | |
| 8. Beam Port and Thermal Column Status | | | | | |
| 9. Linear Channel | Zero | | | | |
| | Meter Reading | | | | |
| | Scale | | | | |
| 10. Linear C.I.C. Voltages | HV (~540) | | | | |
| | CV (~ 2 to 8) | | | | |
| 11. Recorders On, Dated, "RCD" Light On Temp. & CAM Recorders | | | | | |
| 12. Core Check (Lights On) | Level Check | | | | |
| | Inspect Core | | | | |
| | Source Inserted | | | | |
| 13. Start-Up Channel Test | | | | | |
| 14. Verify FC Response, FC Inserted, Count Rate > 2 CPS | | | | | |
| 15. Log Count Rate HV Power Supply (+400 VDC) | | | | | |
| 16. Log and Power Range Test | | | | | |
| 17. Period Response Test | | | | | |
| 18. Magnet Power On, Scram Reset, Board Reset | | | | | |
| 19. Inlet Temperature (°F) | | | | | |

Rev.

Reviewed By: William Bonzer William Bonzer

Approved By: David Freeman David Freeman

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## HOURLY OPERATING LOG

Date __________________ (Start a new form each day)

Signatures: (1) ______________________ (4) ______________________
(Including Licensed (2) ______________________ (5) ______________________ Rev.
Operator on Duty) (3) (6)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Time at Power | | | | | | | | | | | | | |
| 2. Initials - Person at Console | | | | | | | | | | | | | |
| 3. Nominal Power (W or kW) | | | | | | | | | | | | | |
| 4. Linear Recorder (%) | | | | | | | | | | | | | |
| 5. Linear Scale (W or kW) | | | | | | | | | | | | | |
| 6. Auto Set/Board Reset ( Y or N) | | | | | | | | | | | | | |
| 7. Log Level (%) | | | | | | | | | | | | | |
| 8. Period Trace Normal (√) | | | | | | | | | | | | | |
| 9. Log and Linear Power Range (%) | | | | | | | | | | | | | |
| 10. Log Count Rate Recorder (cps) | | | | | | | | | | | | | |
| 11. Source Removed? (Y or N) | | | | | | | | | | | | | |
| 12. Diffuser(s) On? (Y or N) | | | | | | | | | | | | | |
| 13. Exhaust Fan On? (Y or N) | | | | | | | | | | | | | |
| 14. Shim Rod No. 1 (inches) | | | | | | | | | | | | | |
| 15. Shim Rod No. 2 (inches) | | | | | | | | | | | | | |
| 16. Shim Rod No. 3 (inches) | | | | | | | | | | | | | |
| 17. Regulating Rod (inches) | | | | | | | | | | | | | |
| 18. Radiation Levels Normal (√) | | | | | | | | | | | | | |
| 19. Bridge Monitor (mr/hr) | | | | | | | | | | | | | |
| 20. Magnet Currents Normal (√) | | | | | | | | | | | | | |
| 21. Power Chamber No. 1 (%) | | | | | | | | | | | | | |
| 22. Power Chamber No. 2 (%) | | | | | | | | | | | | | |
| 23. Permanent Log Entries (√) | | | | | | | | | | | | | |
| 24. Core Inlet Water Temp. (°F) | | | | | | | | | | | | | |
| 25. Licensed Operator Initials | | | | | | | | | | | | | |

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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.~~ 11/[illegible]

~~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.

Written By: David Freeman Approved By: Albert Bolon

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**UMR REACTOR EMERGENCY PHONE LIST**

| **Reactor Staff** | **CELL** | **HOME** | **WORK** | |
|---|---|---|---|---|
| William Bonzer, Sr. El. Tech., SRO, Interim Manager | 465-5544 | 368-3727 | 341-**4291** | Rev. |
| Jim Jackson, Sr. Lab Mechanic, RO | | (573) 699-4897 | 341-**4291** | |
| Nick Tsoulfanidis, Radiation Safety Officer, Interim Director | | 341-3595 | 341-**4745** | |
| Ray Bono, Health Physicist | | 364-5728 | 341-**4240**,4305, 4403 | |
| Mendy Kell, Senior Secretary | | (573) 265-5832 | 341-**4236** | |
| **University Administrative Staff** | | | | |
| 1. Director, UMR Police, William Bleckman | | 364-1294 | 341-**4345** | Rev. |
| 2. Chancellor, John Park | **341-4118** | 364-6455 | 341-**4114** | |
| 3. Vice Chancellor for Admin. Services, Mohammad H. Qayoumi | | 308-1067 | 341-**6906**, 4122 | |
| 4. Director, Physical Plant, Marvin Patton | | 364-6278 | 341-**4252** | |
| 5. Director, Health Service - Infirmary, Dwight Deardeuff, MD | | 364-0809 | 341-**4284** | |
| 6. Dean, School of Mines and Metallurgy, Lee W. Saperstein | | 368-3782 | 341-**4153** | |
| 7. Radiation Safety Officer, Nick Tsoulfanidis | | 341-3595 | 341-**4745** | |
| Local | | | | |
| UMR University Police | | 341-**4300** | 341-4111 | |
| Rolla City Police | | | **9-911** | |
| Rolla Fire Department | | | **9-911** | |
| Phelps County Hospital | | | **9-911** | |
| Rolla Emergency Management Agency | | | **9-911** | |
| **State Agencies** | | | | |
| Missouri Highway Patrol | | | **368-2345** | |
| Missouri State Emergency Mgt. Agency (24 hr.) | | | **(573) 751-2748** | |
| Missouri Dept. of Natural Resources (24 hr.) | | | **(573) 634-2436** | |
| Missouri Bureau of Environmental Epidemiology | | (573) 751-6160 | (573) 751-4674(after hrs) | |
| **Federal Agencies** | | | | |
| NRC, Lisle, IL, Region III | | | **1-800-522-3025** | |
| NRC Duty Officer (24 hour) | **(301) 816-5100** | (301) 951-0550 | (301) 415-0550 | |
| **Other** | | | | |
| American Nuclear Insurers | | | **(860) 561-3433** | |
| Radiation Emergency Assistance Center | | **(423) 576-3131** | (423) 481-1000 (24 hrs) | |

Revised 03/20/00

Revised By: William Bonzer — Approved By: Nicholas Tsoulfanidis

b. communicating with and requesting assistance from the following State and Federal Agencies as required:
   - Missouri State Highway Patrol: 368-2345
   - U.S. Nuclear Regulatory Commission, Region III: 1-800-522-3025 Rev.
   - NRC Duty Officer (24 hr.): (301) 816-5100, (301) 951-0550, or (301) 415-0550
   - Missouri State Emergency Management Agency: (573) 751-2748
   - Missouri Bureau of Environmental Epidemiology: (573) 751-6160 or (573) 751-2748 (24 hrs)
   - Missouri Department of Natural Resources (24-hr. emergency number): 634-2436
   - Radiation Emergency Assistance Center (Oak Ridge, TN): (615) 576-3131; or (615) 481-1000 (24 hours).
   - Rolla Emergency Management Agency: 364-1213

c. notifying the University of Missouri President and requesting University-Wide assistance, as needed.

d. acting as Administrative spokesman responsible for communications with the news media and city officials in the absence of both the Vice Chancellor and the Dean.

2. <u>Vice Chancellor</u> - If offsite consequences are expected the Vice Chancellor will be responsible for:

   a. assuming the duties of the Chancellor in his absence.
   b. functioning as administrative spokesman responsible for communication with the news media and city officials.
   c. assisting in the coordination of Control Group activities in the planning and preparation phase.
   d. notifying American Nuclear Insurers (203) 561-3433 as soon as possible after declaration of an Alert or Site Area Emergency.
   e. advising the Chancellor on problems relating to insurance and liability.

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*William Bonzer*

Approved By: David Freeman
*David Freeman*

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## A. TORNADO IN IMMEDIATE VICINITY OF REACTOR BUILDING

1. SCRAM reactor.

2. Remove and secure the magnet power key.

3. Announce over the building PA that all personnel are to immediately proceed to the rear of mid-level basement due to the tornado threat.

4. Close the security door.

5. Go to the rear of the mid-level basement area near the sink for shelter and wait for the tornado to pass. Rev.

6. If convenient, shelter may be sought in the subbasement cage area.

7. Make certain physical security is re-established as soon as possible after tornado has passed.

8. The Reactor Director will evaluate the situation to determine whether or not an Unusual Event should be declared per the Emergency Plan.

## B. TORNADO WARNING

1. Complete normal reactor shutdown if time permits, otherwise go to Step 1 above. The reactor is to shutdown when a tornado warning is in effect. Rev.

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William Bonzer

Approved By: David ~~Freeman~~an
[signature]

of the dose. Therefore, consideration should be given to limits of error associated with the specific instruments and techniques used to estimate the dose rate. This is especially crucial when the estimated dose approximates 75 rem or more.

2. Planned whole body dose shall not exceed 75 rem.

3. Planned dose to hands and forearms shall not exceed an additional dose of 200 rem.

4. ~~Internal exposure shall be minimized by the use of the best available respiratory protection, and~~ Contamination should be controlled by the use of protective clothing. WB 11/15/

5. Rescue personnel shall be volunteers or professional rescue workers.

6. Rescue personnel should be broadly familiar with the consequences of exposure.

7. Women capable of reproduction shall not take part in these actions.

8. Other factors being equal, volunteers above the age of 45 should be selected.

9. Generally, exposure under these conditions shall be limited to once in a lifetime.

10. In the event that any person exceeds any exposure limit, the Health Physicist shall be notified. If whole body exposures greater than 25 rem are received, the person shall be placed under medical observation. The Physician will determine if medical treatment is required.

11. Persons receiving exposures as indicated above should avoid procreation for a period up to a few months.

## D. PROCEDURE - ACTIONS TAKEN IN LESS URGENT EMERGENCIES

This procedure applies under less urgent circumstances where it is desirable to enter a hazardous area to protect facilities, eliminate further escape of effluents, or to control fires.

Ray Bono

Revised By: Ray Bono

Albert Bolon

Approved By: Albert Bolon

1. Evaluation of the inherent risks should be based on the reliability of the prediction of radiation injury. This reliability cannot be any greater than that the reliability of the estimation of the dose. Therefore, consideration should be given to limits of error associated with the specific instruments and techniques used to estimate the dose rate.

2. Planned whole body dose shall not exceed 25 rem.

3. Planned dose of hands and forearms shall not exceed 100 rem.

4. ~~Internal exposure shall be minimized by respiratory protection and~~ Contamination controlled by the use of protective clothing. wBDk 11/15/??

5. Persons performing the planned actions should be volunteers and familiar with the consequences of exposure.

6. Women capable of reproduction shall not take part.

7. Normally, if the actual dose from these actions is a substantial fraction of the dose limits, such actions should be limited to once in a lifetime.

8. In the event that any person exceeds any exposure limit, the Health Physicist shall be notified. If whole body exposures greater than 25 rem are received, the person shall be placed under medical observation. The Physician will determine if medical treatment is required.

Ray Bono
Revised By: Ray Bono

Albert Bolon
Approved By: Albert Bolon

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b. Position the air sample tank and ~~open the valve~~ collect the sample using an air pump. Allow the tank to completely fill ~~(45 seconds)~~ and note the time and date of the sampling.

c. When sampling is complete, close the tank valves.

4. Analysis

a. Immediately transfer, within 10 minutes, the air sampling tank to the NaI detector in the Health Physics counting room. Position the tank inside of the lead shield by placing the tank in the lead shield with the hole for the detector on top. This allows the 3x3 NaI to be placed inside the tank without placing the weight of the tank on the detector.

b. Count the sample on a range of about 0 to 2 MeV for at least 600 seconds with the detector shielded.

c. When the count is complete, set the start and stop channels to include the 1.294 MeV $^{41}Ar$ peak region, print out the spectrum and integrate.

5. Calculations

a. Determine the background count by integrating over the same channels in which the peak of the $^{41}Ar$ sample occurred. The background count should be done prior to the sample and enough channels printed out to obtain the background integral.

b. Do a background subtraction from the peak as follows:

$N = G - B$ where,

N = Net number of counts in the 1.294 MeV peak of $^{41}Ar$ (counts)

G = Gross number of counts in the 1.294 MeV peak of $^{41}Ar$ as determined in the integration of the printed spectrum (counts)

B = Gross number of counts found by integrating the background count over the same channels as G above (counts)

Revised By: Ray Bono

Approved By: Albert Bolon

8. Repeat the above procedure for all three RAM's.

9. Reset the alarm setpoints as follows:

| Location | Set Point | Function |
|---|---|---|
| Reactor Bridge | 15 mrem/hr<br>20-25 mrem/hr | Rundown<br>Bldg. Evacuation |
| Demineralizer | 15 mrem/hr | Rundown |
| Experiment Room | 15 mrem/hr | Rundown |

10. Verify that the setpoints are correct using the alarm test buttons.

11. Verify that all readings are within ± 20% of the calculated values.

12. The completed form is to be approved by both the Reactor Manager and Health Physicist.

## D. PROCEDURE - NEUTRON RAM CALIBRATION

1. Calibrate the Neutron RAM using Pu-Be source M-169.

2. Fill in the "calculated mR/h" column on the "Neutron RAM Calibration Form" based on the year using the following table (Note: Values presented below are from UMRR-99-1, W. Bonzer): Rev.

| DISTANCE (inches) | YEAR | | | | | |
|---|---|---|---|---|---|---|
| | 1995 to 1999 | 2000 to 2004 | 2005 to 2009 | 2010 to 2014 | 2015 to 2019 | 2020 to 2024 |
| 12 | 117 mR/h | 120 mR/h | 121 mR/h | 122 mR/h | 123 mR/h | 123 mR/h |
| 24 | 37 mR/h | 38 mR/h | 38 mR/h | 38 mR/h | 39 mR/h | 39 mR/h |
| 36 | 22 mR/h | 23 mR/h | 23 mR/h | 23 mR/h | 23 mR/h | 23 mR/h |

Revised By: William Bonzer William Bonzer

Approved By: David Freeman David Freeman

3. Assemble the neutron calibration rig adjacent to the detector. (Note: the calibration is specific to the source-to-detector orientation of the neutron calibration rig. If different source-to-detector orientations are used, the calibration values will have to be recalculated - see UMRR 99-1 (W.Bonzer). Rev.

4. The person handling the source should handle it remotely by using the extension handle provided with the source.

5. Place the source in the neutron calibration rig at the different distances from the detector, then stand away from the source to minimize exposure during the calibration. (Note: distances refer to the center-to-center distance for the detector and source.)

6. Exposure levels in the immediate area shall be determined with a hand-held neutron survey meter when the source is first exposed and again when it is put back in its shield to ensure the radiation levels are ALARA.

7. Record the values displayed in the control room in units of millirems per hour (mR/h) on the "Neutron RAM Calibration Form".

8. Verify that all readings are within about $\pm$ 20% of the calculated values. It is understood that the logrithmic output of the neutron RAM may be difficult to read to within $\pm$ 20% of certain values. In such instances, the person performing the calibration should use their best judgement in reading the meter.

9. If the Neutron RAM fails to meet the calibration specifications, adjust the Neutron RAM calibration according to the equipment technical manual, Section V.E.3.c.1-7 page 36.

10. Set the alarm setpoint to less than or equal to an indicated 20 mrem/hr.

11. The completed form is to be approved by both the Reactor Manager and the Health Physicist.

Revised By: William Bonzer
William Bonzer

Approved By: Nicholas Tsoulfanidis
Tsoulfanidis

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A. Purpose

In accordance with Technical Specification 6.2.~~2~~ 3 each project shall be reviewed and approved prior to insertion in the reactor.

WB 11/15/99

B. Precautions, Prerequisites, or Limitations

The use of the reactor shall be restricted to persons listed on an approved Project Request Form. The exception to this is the pilot run of a project which is in its initial stage.

Section 3.7.2 (Experiments) of the Technical Specifications limits the type of materials that shall be irradiated at this facility. ~~In addition to the limits in this Section plastics shall not be exposed to a neutron fluence in excess of $1x10^{16}$ neutrons/$cm^2$~~.

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

C. Procedure

The individual who will be in charge of the project will be responsible for properly completing a Project Request Form (Form SOP 701). After a review by the Reactor Staff, the request is forwarded to the Reactor Director, or in his absence to the Reactor Manager. Only after their approval a project number is assigned and an experimenter allowed to run experiments. Copies of the approved Project Request Form are distributed: one copy to the Health Physics Office, one copy to the Reactor Facility, and one copy to the originator. If the project contains an "untried" experiment or one which is significantly different from those previously performed in the reactor a review and an approval by the Radiation Safety Committee must be sought (Technical Specifications 6.2.3).

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

Instructions for completing the Project Request Form are given below for some particular items:

WRITTEN BY: MILAN STRAKA APPROVED BY: ALBERT BOLON

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C. Beam Tube Access After Reactor Operation
Access to the beam tube should be attempted only after the reactor has been shutdown and permission has been obtained by the reactor operations personnel. The removal of the shield plugs from the beam hole facility can be done only when there are no elements in the reactor core or when the reactor bridge and core are sufficiently removed from the beam tube such that the pool water serves as a shield. Refer to SOP 111 for bridge movement procedure.

D. General Procedure For Using Beam Hole Facility

1. Obtain necessary approval for utilization of facility.

2. ~~Prepare complete schedule of program, including preparation time, length of run, reactor downtime, post-irradiation work, etc.~~ WB DWF 11/15/9?

3. Remove beam hole flange and shield plugs.

4. Insert necessary sample, equipment etc into beam tube.

5. Insert beam hole plugs.

6. Bolt beam hole flange in place.

7. Advise reactor operations that experiment is ready for reactor operation.

8. When the reactor operational requirements have been completed, access to the beam tube is to be carried out according to steps (9) through (13) which follow:

9. Obtain approval from the reactor operator for removal of the shield plugs. This may require the unloading of the reactor core, the movement of the core and bridge from the immediate vicinity of the beam tube or a combination of both. See SOP ~~111~~ 200 for bridge movement procedure. (12/5/96 WB DWF)

10. Remove blank flange and shield plugs from facility in the presence of the Health-Physics Officer, or Senior Operator.

11. Remove experimental material from tube.

WRITTEN BY: A.E. Elliott | APPROVED BY: D.R. Edwards DRE

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UNIVERSITY OF MISSOURI-ROLLA - NUCLEAR REACTOR

RLB DW STANDARD OPERATING PROCEDURES

| S.O.P.: ~~114~~ 712 3/29/94 | REVISED: 7-24-75 | PAGE 1 OF 2 |
|---|---|---|

TITLE: Thermal Column Facility

A. Introduction

The thermal column is located at the experimental end of the reactor pool. It consists of a column of graphite approximately 4 ft. square and 5 ft. long which terminates at one of the reactor core faces. A 4 inch thick lead shield is provided between the core and the graphite region during operation, thereby giving rise to a relatively pure region of thermal neutrons for irradiation purposes. A movable shield door is provided at the rear of the column to permit access to the thermal column internals when the reactor is shutdown. Five holes are provided in the door to facilitate access to the thermal column for experimental work. These plugs must be in place during reactor operation. C.W. Dwg. R-106000 shows the assembly arrangement of this facility.

B. General Procedure for Using Thermal Column Facility

1. Obtain necessary approval for utilization of the facility.

2. ~~Prepare complete schedule of program including preparation time, length of run, reactor downtime, post irradiation work, etc.~~ WB 11/15/9-

3. Prepare thermal column experiment including graphite removal, equipment setup, etc.

4. Close thermal column door if open.

5. Replace all thermal column door plugs.

6. Advise reactor operations that experiment is ready for reactor operation.

7. When the reactor operational requirements have been completed, access to the thermal column is to be carried out according to steps (8) through (10).

8. Obtain approval from the reactor operator for removal of the shield plugs. This may require the unloading of the reactor core, the movement of the core and bridge from the immediate vicinity of the thermal column or a combination of both. See SOP ~~111~~ 200 for bridge movement procedure.

12/5/96 WB DW

| WRITTEN BY: A.E. Elliott | APPROVED BY: D.R. Edwards DRE |
|---|---|

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b. Fission Chamber Preamp

| | Initial | Date |
|---|---|---|
| (1) Cleaned chassis as needed | _____ | __________ |
| (2) Additional Comments | | |

c. Log Count Rate Channel Calibration
(Note: All readings should give 0.7 to 1.4 ratio of true-to-observed readings.)

| Pulse Generator | Meter | Recorder | Initial | Date |
|---|---|---|---|---|
| 10 | | | | |
| 100 | | | | |
| 1,000 | | | | |
| 10,000 | | | | |

d. High Voltage__________(350 VDC to 450 VDC) _____ __________ Rev.

e. Reconnect all cables

Reconnection of cables verified _____ __________

4. **Safety Channels**

a. Safety Preamp
(1) Cleaned chassis as needed _____ __________

b. Safety Detector UIC #1
(1) Signal Cable Resistance: _____Meg ohms _____ __________

(2) High Voltage Cable Resistance: _____Meg ohms _____ __________

c. Safety Detector UIC #2
(1) Signal Cable Resistance: _____Meg ohms _____ __________

(2) High Voltage Cable Resistance: _____Meg ohms _____ __________

d. Safety Amplifier
(1) Cleaned chassis as needed _____ __________

e. Safety Amplifier Adjustments _____ __________

f. Reconnect all cables _____ __________

Reconnection of cables verified _____ __________

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## A. PURPOSE

To ensure that the log count rate channel is operational.

## B. Precautions, Prerequisites And Limitations

1. In accordance with Technical Specification 4.2.2 all console instruments and safety system shall be calibrated twice each year, not to exceed 7 ½ months.

2. After each item is completed, a second knowledgeable person will check connections (where connections have been broken and reconnected) to ensure that the equipment is connected and on line. This step is very important because failure to reconnect some of the equipment can cause violations of the Technical Specification, if the reactor is operated.

## C. Procedure

A list of equipment in the form of a checklist will be used to record the date that each system was checked or calibrated. Procedures listed in the equipment manuals have been reprinted in the form of SOP's. As each equipment is checked or calibrated, it shall be checked off on the checklist, to ensure that the list has been completed and to serve as a record of date when the item was completed.

1. Using a vacuum cleaner and soft bristled brush, clean LCR drawer, if needed. Note: No electronic components are exposed. Drawer can be vacuumed without disconnecting AC power.

2. Log Count Rate channel equipment must have power applied and warmed up for at least 25 hours.

3. Turn power on to pulse generator and allow to warm up for 30 minutes.

4. Turn power on to oscilloscope and allow to warm up for 30 minutes.

5. Turn power on to counter/timer system and allow to warm up for 30 minutes.

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6. Set pulse generator as follows:

| | |
|---|---|
| Frequency | 10-700 cps |
| Pulse Width | 5 micro sec |
| Polarity | + |
| Amplitude | At zero (0) |
| Attenuator | 1 |
| Rise Time | 0.1 micro sec |
| Mode | Internal |

7. Set Counter/Timer as follows:

   0.1 sec/0.01 min switch 0.1
   Present Time N=6, $10^M$=2

8. Connect Red and Black clips from electrometer to signal cable going to fission chamber.

9. Read resistance and record. (Since this is a check of insulation resistance, the readings will be very high. If readings have decreased from that of the last check, deterioration of cables and/or chambers is indicated and should be replaced.

10. Connect pulse generator output to counter/timer.

11. Adjust frequency (course and fine controls) until a pulse rate of 10 CPS is obtained. Connect output of pulse generator to LCR. Check this reading with that on meter on Log Count Rate drawer. Reading must be a 0.7 to 1.4 ratio of true-to-observed reading.

12. Check reading of chart recorder. Reading should be a 0.7 to 1.4 ratio of true-to-observed reading.

13. Repeat steps 10, 11 and 12 for pulse rates of $10^2$, $10^3$, and $10^4$.

14. If reading is out of tolerance, calibrate instrument in accordance with procedures in Technical Manual.

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David Freeman

15. Disconnect output of pulse generator from LCR.

16. Reconnect the normal input to LCR. Rev.

17. Remove the high voltage cable from the high voltage power supply.

18. Measure the high voltage output of the power supply. High voltage should measure between 350 VDC and 450 VDC. Adjust to 400 VDC if out of range.

19. Reconnect the high voltage cable to the high voltage power supply.

20. Second person to independently check connections.

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