



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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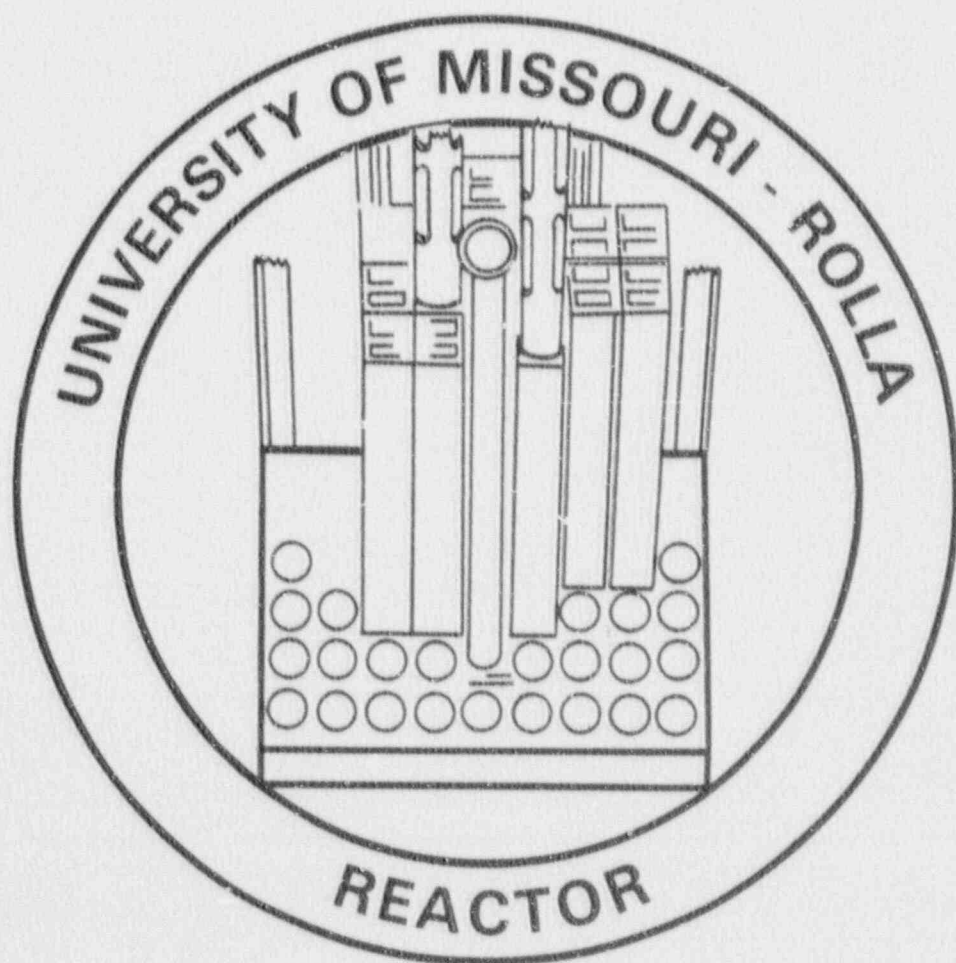
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Progress Report

1990-91

University of Missouri-Rolla

Nuclear Reactor Facility



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
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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

| <u>Name</u> | <u>Title</u> |
|-----------------------------|------------------------------|
| 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

| <u>Name</u> | <u>License</u> |
|-----------------------------|------------------|
| Albert E. Bolon | Senior Operator |
| Carl Barton | Senior Operator |
| David Freeman ²⁾ | Senior Operator |
| Francis Jones | Senior Operator |
| Matt McLaughlin | Reactor Operator |

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:

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

| <u>Name</u> | <u>Title</u> |
|-----------------------------------|---|
| 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, 1990LOADING 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 |

| 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 | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | BRIDGE SIDE | | | UMRR CORE STATUS | | | | | |

KEY TO PREFIXES

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

Other BRT - Bare Rabbit Tube
CRT - Cadmium Rabbit Tube

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

Table 2. Facility Use Other Than The Reactor

| <u>Facility</u> | <u>Hours</u> |
|------------------|--------------|
| 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

| <u>Date</u> | <u>Cause and Corrective Action</u> |
|-------------|--|
| 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

| <u>Date</u> | <u>Cause</u> |
|-------------|---|
| 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-Annals)

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-Annals 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-Annals 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-Annals started.

Date: 12/20/90
Problem: N/A
Corrective Action: Semi-Annals 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 Thermal Flux | 1.6×10^{12} n/cm ² -sec at 200 kW |
| Maximum Thermal Flux | 2.8×10^{12} n/cm ² -sec at 200 kW |
| Average Epithermal Flux | 1.6×10^{11} n/cm ² -sec at 200 kW |
| Worth of Thermal Column | 0.46% $\Delta k/k$ |
| Worth of Beam Port | not detectable |

Rod Worths (in "T" mode):

Rod 1: 2.63% $\Delta k/k$ (4/16/79)Rod 2: 2.65% $\Delta k/k$ (4/16/79)Rod 3: 3.36% $\Delta k/k$ (4/16/79)Reg Rod: 0.34% $\Delta k/k$ (9/14/89)Excess Reactivity (in "W" mode): 0.6% $\Delta k/k$ Shutdown Margin (in "W" mode)*: 4.7% $\Delta k/k$

* 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.

| <u>Course</u> | <u>Semester</u> | <u>Title</u> | <u>Credit Hours</u> | <u>Students</u> | <u>Reactor Hours</u> |
|---------------|--------------------------|-------------------------------------|-------------------------|-----------------|--------------------------|
| 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} $\mu\text{Ci/ml}$.

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. Shipment of HEU Fuel Offsite

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. Reactor Utilization

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

CONTROLLED COPY

*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 100

TITLE: PREAMBLE

Total Revision: September 12, 1990

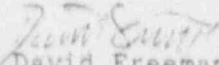
Page 1 of 1

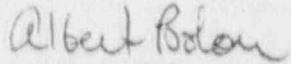
A. Purpose

The purpose of this document is to set forth the procedures for routine and emergency operations of the University of Mississippi 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 mandated that all personnel involved with reactor operations be completely familiar with these procedures and that these procedures be followed.

B. Precautions, Prerequisites, or Limitations

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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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 101

TITLE: GENERAL OPERATIONAL PROCEDURES

Revised: September 12, 1990

Page 1 of 3

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.

Written By:  David Freeman

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 101

TITLE: GENERAL OPERATIONAL PROCEDURES

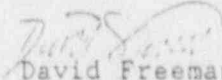
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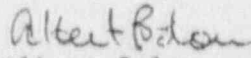
September 12, 1990

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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).
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.
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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Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 101


TITLE: GENERAL OPERATIONAL PROCEDURES

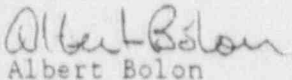
Revised:

September 12, 1990

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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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Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990

Page 1 of 8

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.

Written By:  David Freeman

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990


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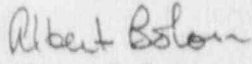
2. Record the time that is shown on the reactor console clock translated into military time.
3. Your initials.
4. Enter core loading number and mode.
5. Check or turn on these units. Number 6 is the bridge intercom.
6. Announce, "The building alarm will sound. This is a test. Do not evacuate the building."
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."
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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Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***


SOP: 102

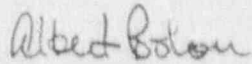
TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990

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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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Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990


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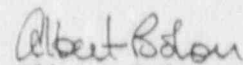
21. Turn period "CALIBRATE" switch. Hold until period recorder reads 6 seconds. Check the annunciator panel for Log N and Period Nonoperative, 30 sec and 15 sec periods lights. Push acknowledge and board reset.

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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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

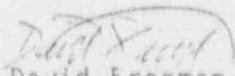
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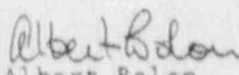
Revised: August 14, 1990

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- b. Push in and turn trip test knob on the period section of the Log N Amplifier.
- 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 both logs.
31. Inspect the core. Make certain core cooling is clear and experiments are firmly secured.
32. Announce, "The reactor will be started and taken to a power of _____ watts (or ____kilowatts)".
33. Record the intended power level, including W or kW.

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Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***


SOP: 102

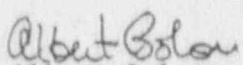
TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990

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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.

Written By: 
David Freeman

Approved By: 
Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990

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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 | | No. 1 | | | | |
| (Required when P > 20kW) | | 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 | | | | | |
| | No. 1 - (Hold meter range switch down) | | | | | |
| | No. 2 - Log N | | | | | |
| | No. 2 - (Hold meter range switch down) | | | | | |
| 13. Recorders: On, Ink, Paper, Date | | | | | | |
| 14. Pool | Lights On, Level Check, | | | | | |
| | 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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Rev.

REV. 8/14/90

Written By: David Freeman

Approved By: Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 102

TITLE: PRE-STARTUP CHECKLIST PROCEDURES

Revised: August 14, 1990

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UMR 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.

Written By: David Freeman

REV. 8/14/90

Approved By: Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 204

TITLE: DEMINERALIZER REGENERATION

Revised: August 10, 1990

Page 1 OF 7

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

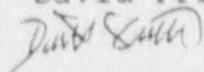
1. Inform the Reactor Manager that the regeneration is being started.
2. Two personnel should be present dressed in lab coats and eye protection for all caustic and acid transfers.
3. The Reactor Manager should be informed when the system is returned to service.
4. Ensure water flow to the make-up sump 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.

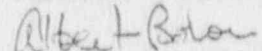
Rev.

Rev.

Written By: David Freeman



Approved By: Albert Bolon



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***UMR REACTOR STANDARD OPERATING PROCEDURES ***
SOP: 204 TITLE: DEMINERALIZER REGENERATION
Revised: August 10, 1990

Page 2 OF 7

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
 - 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

Rev.

Written By: David Freeman

David Freeman

Approved By: Albert Bolon

Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 204 TITLE: DEMINERALIZER REGENERATION
Revised: August 10, 1990

Page 3 OF 7

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

Written By: David Freeman

David Freeman

Approved By: Albert Bolon

Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 204 TITLE: DEMINERALIZER REGENERATION

Revised: August 10, 1990

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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.

Written By: David Freeman

Approved By: Albert Bolon

David Freeman

Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 204 TITLE: DEMINERALIZER REGENERATION
Revised: August 10, 1990

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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

Written By: David Freeman

David Freeman

Approved By: Albert Bolon

Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***
SOP: 204 TITLE: DEMINERALIZER REGENERATION
Revised: August 10, 1990

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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 Rev. 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.
 - 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

Written By: David Freeman

David Freeman

Approved By: Albert Bolon

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***UMR REACTOR STANDARD OPERATING PROCEDURES ***

SCP: 204 TITLE: DEMINERALIZER REGENERATION

Revised: August 10, 1990

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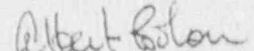
35. Discharging to Basement Sump:

- 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



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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 205

TITLE: DEMINERALIZER REGENERATION WASTE WATER
ANALYSIS AND RELEASE

Complete Revision: August 10, 1990

Page 1 of 4

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)

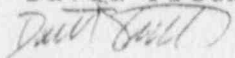
Multichannel analyzer with Germanium or

Sodium Iodide detector.

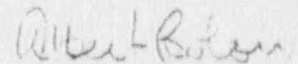
C. ANALYSIS PROCEDURE

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



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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 205

TITLE: DEMINERALIZER REGENERATION WASTE WATER ANALYSIS AND RELEASE

Complete Revision: August 10, 1990

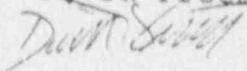
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7. Count the sample(s) in the same geometry and for the same length of time as the standard. (The standard, background and sample(s) should be counted in succession with no excessive delays between counts.) Print out the gross integral between 0-2 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".

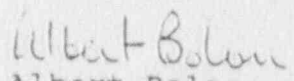
D. DISCHARGE PROCEDURE

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} $\mu\text{Ci/ml}$ 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} $\mu\text{Ci/ml}$ above background, the Health Physicist (or his designee) must authorize (by signature) the release.

Written By: David Freeman



Approved By: Albert Bolon



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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 205

TITLE: DEMINERALIZER REGENERATION WASTE WATER
ANALYSIS AND RELEASE

Complete Revision: August 10, 1990

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- 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 $1.5 \times 10^{-5} \mu\text{Ci/ml}$, 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
David Freeman

Approved By: *Albert Bolon*
Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 205

TITLE: DEMINERALIZER REGENERATION WASTE WATER
ANALYSIS AND RELEASE

Complete Revision: August 10, 1990

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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_0): 1.88×10^{-2} μCi on 10/1/78
Decayed Source Activity $A(t)$: _____ μCi
Fixed Geometry Description _____

Source ct rate _____ \pm _____ cpm
- Background ct rate _____ \pm _____ cpm
Differential ct rate _____ \pm _____ cpm

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

II. Sample Activity Determination

Sample ct rate _____ \pm _____ cpm
- Background ct rate _____ \pm _____ cpm
Differential ct rate _____ \pm _____ cpm

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

Approved By: Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 505

TITLE: ENHANCED REACTOR SECURITY

Revised: November 12, 1990

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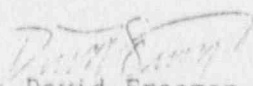
In the event of any disorder on the campus of the University of Missouri-Rolla such as civil strife or demonstrations which could for any reason have an effect on the security of the Reactor Facility the following steps will be observed:

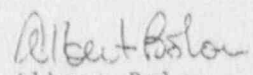
Rev.

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

Rev.

Del.

Written By:  David Freeman

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 510

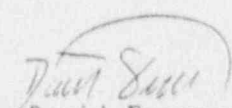
TITLE: EARTHQUAKE

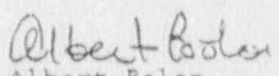
Revised: September 12, 1990

Page 1 of 1

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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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 604

TITLE: RELEASE OF BY-PRODUCT MATERIALS ON CAMPUS

Revised: July 31, 1990

Page 1 of 3

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.

Written By:  Ray Bono

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 604

TITLE: RELEASE OF BY-PRODUCT MATERIALS ON CAMPUS

Revised: July 31, 1990

Page 2 of 3

5. Swipe the outside of the outer package for contamination and count the swipes. The swipes must not be >220 dpm/cm² for beta/gamma or >22 dpm/cm² 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.

Ray Bono

Written By: Ray Bono

Albert Bolon

Approved By: Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 604

TITLE: RELEASE OF BY-PRODUCT MATERIALS ON CAMPUS

Revised: July 31, 1990

Page 3 of 3

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 _____

AT SURFACE DOSE RATE _____ mr/hr

AT 3 FEET _____ mr/hr

INSTRUMENT USED _____

HEALTH PHYSICS APPROVAL _____

SURFACE CONTAMINATION
BETA/GAMMA _____ dpm/cm² Re

ALPHA _____ dpm/cm² Re
(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."

CERTIFIED BY _____ DATE _____

ACCEPTED BY CARRIER _____ DATE _____

Written By: *Ray Bono*
Ray Bono

Approved By: *Albert Bolon*
Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 810

TITLE: WEEKLY CHECK

Revised: September 12, 1990

Page 1 of 14

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 rods will not withdraw if any one of 5 primary recorders is turned off.

Written By:  Carl Barton

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 810

TITLE: WEEKLY CHECK

Revised: September 12, 1990

Page 2 of 14

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.

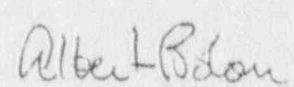
C. Period < 30 Seconds

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.

Written By:  Carl Barton

Approved By:  Albert Bolon

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*** UMR REACTOR STANDARD OPERATING PROCEDURES ***

SOP: 810

TITLE: WEEKLY CHECK

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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. RUNDOWN CHECK (blue lights):

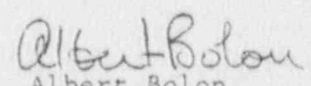
A. Radiation Area Monitoring (RAM) System

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 ≤ 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

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- 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.

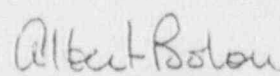
E. Low CIC Voltage Linear Power Supply

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, <

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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. SCRAM (red lights):

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.

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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

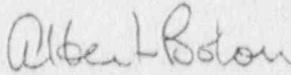
1. Withdraw rods to 3 inches.
2. Turn Log N test from the operate to high or low position.
3. Observe Log N Period Amp Non-Operative Scram, Manual Scram, and that the Magnet contact lights go out. Acknowledge annunciators. Reset Manual Scram and reset annunciator. Insert the magnets.
4. Record results.

Rev.

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.

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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.
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).

Rev.

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.

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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.

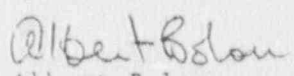
D. Pool Demineralizer Effluent Conductivity High

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. "REACTOR ON" LIGHTS:

- 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.

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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."

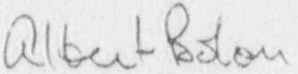
8. NITROGEN DIFFUSERS:

- 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).

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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.

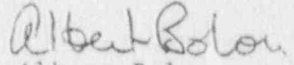
2. Ultrasonics

- 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 ultrasonic 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.

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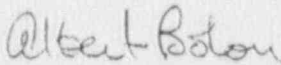
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- b. Momentarily depress the alarm button. The campus police should indicate the satisfactory operation of this alarm.
- 4. Doors
 - a. While holding the dead bolt switch closed, reset the alarm.
 - b. Open one of the exterior doors equipped with an 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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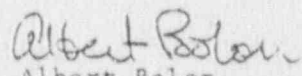
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Date Performed _____

| | | | |
|-------------------------------|-----------------------------|-----------------------------|----------------------------|
| 1. | <u>ROD PROHIBIT</u> | <u>Annunciator Prohibit</u> | <u>Initial</u> |
| 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 | | | |
| | <u>Actual Trip Point</u> | <u>Annunciator Prohibit</u> | <u>Initial</u> |
| | _____ | _____ | _____ |
| C. Period <30 seconds | | | |
| | _____ | _____ | _____ |
| D. Inlet Temperature >135°F | | | |
| | _____ | _____ | _____ |
| E. Shim Rods below shim range | | | |
| | | _____ | _____ |
| 2. | <u>RUNDOWN CHECK</u> | | |
| A. RAM System | | | |
| | | Remote and | |
| <u>Station</u> | <u>Bldg. Alarm</u> | <u>Local Alarm</u> | <u>Annunciator Rundown</u> |
| <u>Trip point</u> | <u>Initial</u> | | |
| 1. | _____ | _____ | _____ |
| 1. | _____ | _____ | _____ |
| 2. | _____ | _____ | _____ |
| 3. | _____ | _____ | _____ |
| B. 120% Demand rundown | | | |
| | <u>Actual Trip Point</u> | <u>Annunciator Rundown</u> | <u>Initial</u> |
| | _____ | _____ | _____ |
| C. Period 15 seconds rundown | | | |
| | _____ | _____ | _____ |

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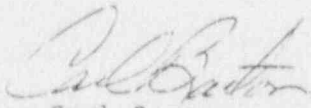
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| | Date _____ | | | |
|----|---|--------------------------|--------------------------|-------------------------------|
| D. | 120% Full Power Rundown | <u>Actual Trip Point</u> | <u>Annunciator</u> | <u>Bundown</u> <u>Initial</u> |
| | | _____ | _____ | _____ |
| E. | Low CIC Linear P S. | _____ | _____ | _____ |
| | | _____ | _____ | _____ |
| F. | Low CIC Log N P.S. | _____ | _____ | _____ |
| | | _____ | _____ | _____ |
| G. | Regulating Rod on Insert Limit on Auto | _____ | _____ | _____ |
| 3. | <u>SCRAM CHECK</u> | <u>Actual Trip Point</u> | <u>Annunciator</u> | <u>Scram</u> <u>Initial</u> |
| 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. | <u>ROD DROP CURRENTS</u> | <u>Drop Current</u> | <u>Contact Light Off</u> | <u>Initial</u> |
| A. | Rod #1 | _____ | _____ | _____ |
| B. | Rod #2 | _____ | _____ | _____ |
| C. | Rod #3 | _____ | _____ | _____ |
| 5. | <u>TEST OF ANNUNCIATORS</u> | | | |
| A. | Beam Room High Neutron Flux | <u>Local Alarm Light</u> | <u>Annunciator</u> | <u>Initial</u> |
| | | _____ | _____ | _____ |

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| | | | | |
|-----|---|-----------------------------------|---------------------------|----------------|
| | | Date _____ | | |
| B. | Interlock Bypass | | <u>Annunciator</u> | <u>Initial</u> |
| | (1) Shim range | | _____ | _____ |
| | (2) 30 second period | | _____ | _____ |
| | (3) Radiation area high | | _____ | _____ |
| | (4) <2 CPS | | _____ | _____ |
| C. | Servo Limits | | | |
| | <u>Lin. Rec. Reading</u> | <u>Permit on at</u> | <u>Permit off at</u> | <u>Initial</u> |
| | _____ % | _____ % | _____ | _____ |
| D. | Pool Demineralizer Effluent Conductivity High | | | |
| | | <u>Local Alarm Annunciator</u> | | <u>Initial</u> |
| | | _____ | | _____ |
| 6. | <u>"REACTOR ON" LIGHTS</u> | | <u>Operational</u> | <u>Initial</u> |
| A. | Main Entrance | | _____ | _____ |
| B. | Control Room | | _____ | _____ |
| C. | Beam Room | | _____ | _____ |
| 7. | <u>BUILDING EVACUATION</u> | <u>Alarm Operational</u> | | <u>Initial</u> |
| | | _____ | | _____ |
| 8. | <u>NITROGEN DIFFUSER</u> | <u>Pump Operational</u> | <u>Indicator Light On</u> | <u>Initial</u> |
| A. | #1 | _____ | _____ | _____ |
| B. | #2 | _____ | _____ | _____ |
| 9. | <u>BEAM PORT AND THERMAL COLUMN WARNING LIGHT</u> | | | |
| | | <u>Annunciator Flashing Light</u> | | <u>Initial</u> |
| A. | Beam Port | _____ | _____ | _____ |
| B. | Thermal Column | _____ | _____ | _____ |
| 10. | <u>SHUT DOWN CHECK LIST</u> | | <u>Completed</u> | <u>Initial</u> |
| 11. | <u>SECURITY SYSTEM</u> | <u>Battery Check</u> | _____ | _____ |
| | | _____ | _____ | _____ |
| 12. | <u>APPROVED AND REVIEWED</u> | | | |
| | | _____ | | |
| | | Manager or Director (Rev. 8/90) | | |

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