



UNIVERSITY OF MISSOURI-COLUMBIA

Research Reactor Facility

Research Park  
Columbia, Missouri 65211  
Telephone (314) 882-4211  
FAX (314) 882-3443

March 3, 1994

Seymour H. Weiss, Director  
U. S. Nuclear Regulatory Commission  
PDNP  
M.S. 11-B-20  
Washington, DC 20555

REFERENCE: Docket 50-186  
University of Missouri Research Reactor  
License R-103

We have sent, under separate cover, two copies of the Reactor Operations Semi-Annual Report for the University of Missouri Research Reactor. The reporting period covers 1 July 1993 through 31 December 1993.

If you have any questions, please feel free to call.

Sincerely,

Walt A. Meyer, Jr.  
Reactor Manager

WAM:bjb

enclosure

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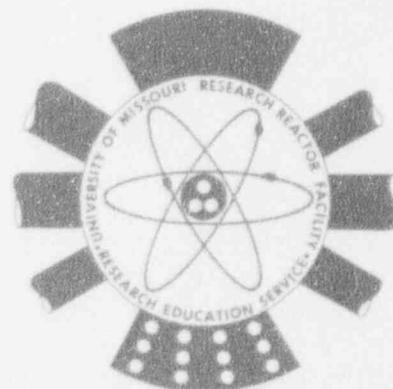


UNIVERSITY OF MISSOURI

# UNIVERSITY OF MISSOURI RESEARCH REACTOR

## OPERATIONS SEMI-ANNUAL REPORT

1 July 1993 - 31 December 1993



RESEARCH REACTOR FACILITY

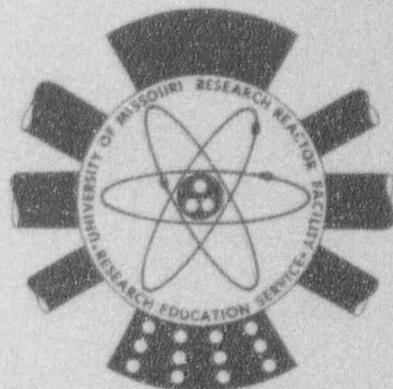


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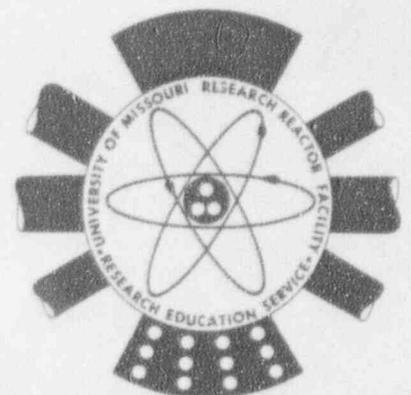


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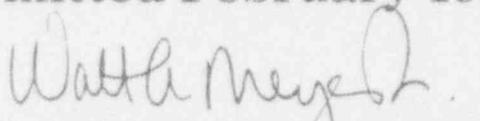
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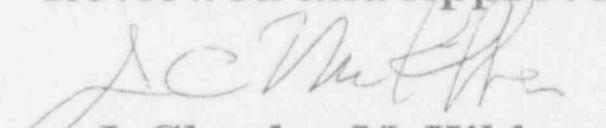
**REACTOR OPERATIONS  
SEMI-ANNUAL REPORT**

**Compiled by the Reactor Staff**

**Submitted February 1994 by**

  
**Walt A. Meyer, Jr.  
Reactor Manager**

**Reviewed and Approved**

  
**J. Charles McKibben  
Associate Director**

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## SECTION I

### REACTOR OPERATIONS SUMMARY 1 July 1993 through 31 December 1993

The following table and discussion summarizes reactor operations in the period 1 July 1993 through 31 December 1993.

| Date                       | Full Power Hours | Megawatt Days | Full Power Percent                 |   |
|----------------------------|------------------|---------------|------------------------------------|---|
|                            |                  |               | of Total Time                      | of Schedule*                              |
| July 1993                  | 679.19           | 283.17        | 91.29                              | 102.24                                    |
| Aug. 1993                  | 653.12           | 275.53        | 87.78                              | 98.32                                     |
| Sept. 1993                 | 646.12           | 269.42        | 89.74                              | 100.51                                    |
| Oct. 1993                  | 679.52           | 283.45        | 91.21                              | 102.16                                    |
| Nov. 1993                  | 615.58           | 256.63        | 85.50                              | 95.76                                     |
| Dec. 1993                  | <u>668.11</u>    | <u>278.60</u> | <u>89.80</u>                       | <u>100.58</u>                             |
| Total for six month period | 3,941.64         | 1,646.80      | 89.24% of Time for 6 mos. at 10 MW | 99.95% of Sched. Time for 6 mos. at 10 MW |

\* MURR is scheduled to average at least 150 hours per week at 10 MW. Total time is the number of hours in a month or half year. A two day maintenance outage (SMP-31) to replace original graphite elements #2 and #3 on Nov. 22-23, 1993, was one reason MURR approached, but did not achieve, its targets of full power operation greater than 90% of total time and 100% of scheduled time.

There were nine unscheduled shutdowns recorded during the six month period 1 July 1993 through 31 December 1993. Of these unscheduled shutdowns, four were scrams and five were rod run-ins (RRIs).

Seven of the unscheduled shutdowns were spurious in nature, with four of the spurious shutdowns attributed to the Trip Actuator Amplifier (TAA) associated with reactor scram and rod run-in circuits. In addition to normally scheduled testing of the TAAs, the electronics technicians have begun a program to systematically renovate the TAA modules by replacing discrete components in the TAA circuits.

#### July 1993

The reactor operated continuously in July with the following exceptions: four shutdowns for scheduled maintenance and refueling; two unscheduled shutdowns.

On July 1, a reactor isolation and reactor scram was initiated when the high voltage circuit board became disconnected in the high range detector module for the reactor bridge, a part of the area radiation monitoring system (ARMS). There was no

high airborne radioactivity level in containment. The disconnected circuit board caused a loss-of-signal to the ARMS module, a condition which automatically initiates a reactor isolation and scram. The circuit board most likely became loose due to vibration during normal operation and sample handling evolutions on the bridge. The circuit board has since been secured to its connector with cable ties and no further problems of this type have occurred.

On July 6, an anti-siphon high level rod run-in occurred during a normal startup after a scheduled maintenance shutdown. Control room operators immediately drained the water from the anti-siphon system and reset the rod run-in. With the reactor subcritical, operators monitored the anti-siphon system for any indication of leakage by the anti-siphon valves (543 A & B). Anti-siphon pressure decreased and stabilized at or near primary system pressure, indicating seepage past one or both of the 543 valves. The reactor was then shutdown to determine the cause of the leak.

The 543 A/B valve operating linkages were visually inspected while being operated pneumatically and manually and were found to be intact and operating freely. After cycling the valves numerous times, the primary system was placed on-line with no evidence of leakage past the valves. The primary system was shutdown and the valves were again cycled numerous times. This is consistent with the procedure called for in Special Maintenance Procedure (SMP-10), Replacement of V543 A/B to seat the valves after replacement of the o-ring seals on the 543 valve discs (4" butterfly valves).

The primary system was then placed on-line and the anti-siphon system pressure was monitored for approximately one hour with no evidence of pressure decrease and therefore no indication of leakage. It appears most likely that this problem was an isolated event where one of the valve disc o-rings did not seat properly in the valve body. The 543 valves were determined to be capable of performing their safety function and no further problems of this type have since occurred.

Major maintenance items for the month included: physically securing with cable ties, the high voltage circuit board in the high range area radiation monitor for the reactor bridge; repairing a pin-hole leak on the secondary shell side of pool heat exchanger (521B); modifying and repairing the rotary switch assemblies for containment ventilation isolation doors 504 and 505. The switch assembly for door 505 malfunctioned twice during testing of the isolation system with the reactor shutdown because it failed to initiate the door gasket inflation sequence required to isolate the return side of the containment ventilation system. A Licensee Event Report describing these events and the corrective actions was forwarded to the Director of Nuclear Reactor Regulation on August 12, 1993.

### August 1993

The reactor operated continuously in August with the following exceptions: four shutdowns for scheduled maintenance and refueling; one unscheduled rod run-in.

On August 16, a rod run-in of unknown origin occurred shortly after a normal startup had been completed following a scheduled maintenance/refueling day. No annunciation or other indication of the rod run-in occurred. The operators had just completed a potentiometer adjustment on the channel #4 wide range monitor. All other reactor indications were normal. The rod run-in was subsequently reset. Investigation of the reactor systems revealed that all reactor and auxiliary systems indicated normal. The reactor was returned to normal operation at 10 megawatts. On the following maintenance day, electronics technicians attempted to determine if the channel #4 (wide range monitor) potentiometer change was related to the rod run-in. They were unable to verify any correlation.

Major maintenance items for the month included: installing and commencing operation of modification package 93-1, Facility Deionized Water Tanks--with this modification, a separate deionized water source (three 420 gallon tanks) has been installed for laboratory users while the main tanks--7,000 gallon T-300 and T-301--remain dedicated to reactor systems; replacing cooling tower fan #3 fan blades and hub assembly and repairing gear box mounting bracket; shipping 8 spent fuel elements in the BMI-1 shipping cask; replacing primary 501B pump; replacing cooling tower fan #2 breaker; transferring into drying barrels depleted pool deionization bed "R" and loading new pool deionization bed "L".

### September 1993

The reactor operated continuously in September with the following exceptions: four shutdowns for scheduled maintenance and refueling. There were no unscheduled shutdowns this month.

On September 7, 1993, while performing compliance testing of the Primary Coolant flow safety channel connected to flow transmitter FT-912E, the scram setpoint for the low flow scram for the heat exchanger 503B leg was below the Limiting Safety System Setpoint (LSSS) of 1625 gpm required by Technical Specification 2.2. A Licensee Event Report detailing the corrective action taken was sent to the Director of Nuclear Reactor Regulation, Washington, D.C., on September 27, 1993.

Significant maintenance activity for the month included: replacing reactor loop flow alarm trip unit 920C; replacing the socket for relay K-38 (reactor loop low flow);

shipping 8 spent fuel elements; replacing the air seals on the actuator for the reactor outlet isolation valve 507A; replacing the yellow scram-leg trip actuator amplifier.

### October 1993

The reactor operated continuously in October with the following exceptions: four shutdowns for scheduled maintenance and refueling; three unscheduled shutdowns.

On October 5, a rod not in contact with magnet rod run-in was automatically initiated when the trip actuator amplifier (TAA) for the "green" leg of the safety system spuriously tripped, dropping rods "C" and "D". There were no safety system trips annunciated for either "green" or "yellow" leg of the safety system. The TAA was replaced with a spare unit and tested satisfactorily. The reactor was refueled and returned to normal operation. The cause of the spurious scram on the "green" leg TAA is similar to one that occurred in Sept. 1991, where differences in the trip point between the "green" and "yellow" leg TAA (~ 1 volt) could allow a small electrical power transient to trip only one TAA. A valid scram signal in either leg would have scrambled all four rods because of the non-coincidence logic circuits.

On the subsequent startup with the reactor subcritical, a rod not in contact with magnet rod run-in occurred when control blade "A" separated from its magnet. The cause was believed to be misalignment between the magnet and control rod anvil (magnet seating surface). The guide tube alignment was checked and the magnet and anvil surfaces were inspected and cleaned. The reactor was returned to normal operation and no further problems of this type have occurred.

On October 7, a spurious reactor loop low pressure scram from pressure transmitter 943 occurred. Reactor loop pressure indications were within the normal pressure band when observed on this and other reactor loop pressure indicators (PT 944A and PT 944B). A compliance check on pressure transmitter 943 indicated that its low pressure scram trip setpoint was one pound (p.s.i.) higher than normal (a conservative direction). The spurious scram occurred as a result of normal meter needle oscillation while operating with system pressure in close proximity to the scram setpoint. The scram trip setpoint was reset to the middle of its trip band and tested satisfactorily. In addition, the alarm trip lamp was replaced and the scram was again retested. No further problems of this type have occurred. We are evaluating the current setpoint ranges for the required pressure scrams and alarms and pressurizer functions, with regard to their relationship to normal operating ranges, to provide greater separation from the scram setpoint and the normal operating band. Over the years, we had continued to move our trip setpoints as close

as feasible to the operating band so all safety trips will occur as far from the LSSS as possible without causing operational problems due to spurious scrams.

Major maintenance items for the month included: replacing the "green" safety system leg trip actuator amplifier; replacing the alarm trip light on the meter for pressure transmitter 943; and filling beamport "B" and "C" experimental cans with deionized water.

### November 1993

The reactor operated continuously in November with the following exceptions: six shutdowns for scheduled maintenance and refueling or sample change-outs. There were no unscheduled shutdowns this month.

Major maintenance items for the month included replacing relay 2K20 (yellow safety leg voltage control to control blades "A" and "B"); and replacing the solenoid for valve 529G which operates valve 509 (pool isolation). Special Maintenance Procedure (SMP-31) was commenced November 22, 1993, as scheduled maintenance to replace graphite reflector elements 2 and 3. This maintenance, which requires pulling back Beamports "B" and "C", was terminated when more than normal leakage (relative to five previous beamport pulling procedures) was experienced pulling Beamport "B", the only beamport that had not previously been pulled back. Reactor and Facilities Operations engineering staff decided that the beamport pulling fixture that had been successfully used on all other beamports would need to be redesigned for pulling Beamport "B". [Editorial note: Additional fixtures and tools were designed and built and SMP-31 was re-initiated February 7, 1994. Beamport "B" was pulled back and its seating surfaces to the biological shield were inspected. There was no evidence of significant corrosion at the seating surfaces. The reason for more than normal leakage was attributed to the original mating of the seating surfaces not being as true as other beamports. The packing ring for Beamport "B" also had only one ring of packing where other beamports had two rings. Graphite elements 2 and 3 were replaced without further problems.]

### December 1993

The reactor operated continuously in December with the following exceptions: four shutdowns for scheduled maintenance and refueling; three unscheduled shutdowns.

On December 3 and again on December 4, spurious rod run-ins occurred with no rod run-in annunciation. There were no abnormal indications evident on any

instrumentation or any rod run-in initiating channels. In each case, the rod run-in trip actuator amplifier (TAA) tripped, causing the control rods to automatically insert. After verifying all operating conditions were normal, the rod run-ins were reset and the reactor was returned to normal operation. On the following maintenance day, December 6, the relays associated with the "rod not in contact with magnet" rod run-in circuit were replaced, the contacts on all other accessible rod run-in relays were cleaned. Additionally, the rod run-in TAA was removed, inspected and tested satisfactorily, and reinstalled. The compliance checks for the effected rod run-in channels were performed satisfactorily and no further spurious rod run-ins have since occurred.

On December 13, a spurious reactor scram occurred while shifting the wide range switch upscale during a normal reactor startup. The cause was suspected to be a sticking relay contact in the feedback network of the picoammeter module for channel #4. The wide range switch was cycled through its full range several times and operated normally. A normal startup was completed with no further problems of this type. The design of the WRM switch and circuitry has historically made it a source of spurious shutdowns. Within the last five years, the number of spurious scrams attributed to the WRM switch has been reduced because of the electronic technicians' preventive maintenance activities for the WRM switch.

Major maintenance items for the month included: loading a new pool deionization bed; replacing a 12 inch PVC spacer in Beamport "F" with 24 inches of lead collimators; replacing relays K-40, K-42, K-44, and K-46 associated with the "rod not in contact with magnet" rod run-in circuit; replacing pressurizer valve 526 (nitrogen addition) due to a stem o-ring air leak; replacing primary pump 501B due to excessive shaft seal leakage; replacing valve 527F (primary demineralizer outlet) position indication micro switches; replacing capacitor C-8 in the primary/pool flow dual trip unit as part of preventative maintenance; replacing air solenoids 529G and 529U for pool isolation valve 509.

## SECTION II

1 July 1993 through 31 December 1993

- A. CHANGES TO THE STANDARD OPERATING PROCEDURES,  
2nd Edition, Effective Date: 5/2/89  
(Revisions #1 through #24 to the October 1981 printing were incorporated.)

As required by the MURR Technical Specifications, the Reactor Manager reviewed and approved the following:

Revision No. 10, dated 7/29/93  
Revision No. 11, dated 8/31/93

- B. CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND  
FACILITY EMERGENCY PROCEDURES  
(dated January 1985, and revised May 13, 1988)  
NOTE: New manual printed May 13, 1988

As required by the MURR Technical Specifications, the Reactor Manager reviewed and approved the following:

Revision No. 13, dated 7/8/93  
Revision No. 14, dated 12/28/93

NOTE: SEP-7, page 2: Social Security Numbers have been omitted per request by Nuclear Regulatory Commission, Al Adams, 9/87.

- C. CHANGES TO HEALTH PHYSICS STANDARD OPERATING PROCEDURES  
NOTE: New manual issued 10/29/90

HP-27, Revision No. 4, dated 8/25/93

- D. MURR SHIPPING PROCEDURES:

SAS-0 (issued 4/13/93), SAS-2 (issued 4/15/93), SAS-3 (issued 4/15/93),  
SAS-4 (issued 2/17/93), SAS-5 (issued 5/17/93)

The revisions to the Standard Operating Procedures, MURR Site Emergency Procedures/Facility Emergency Procedures, and Health Physics Standard Operating Procedures are contained in this section with the part of each page that was revised marked on the right side of the page by a bracket (]).

# STANDARD OPERATING PROCEDURES

2nd Edition, Effective Date: 5/2/89

(Revisions #1 through #24 to the October 1981 printing were incorporated.)

Revision Number 10

Revision Date: 7/29/93

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SECTION I  
ADMINISTRATIVE OPERATING POLICIES

I.1 Purpose

To establish methods of operation for the reactor and associated systems which **ensure** safety and performance within the technical specifications set forth for the University of Missouri Research Reactor. ]

I.2 Scope

These procedures are not to be construed to constitute a part of the technical specifications. In event of any discrepancy between the information given herein and the technical specifications, limits set forth in the technical specifications apply. Changes to these procedures, and to any other special operating or maintenance procedures which have safety significance, must be reviewed by the Reactor Procedures Review Subcommittee (RPRS). Changes which are editorial or have no safety significance may be made by the Reactor Manager, Reactor Operations Engineer or the Shift Supervisor, but must be documented and subsequently reviewed by the RPRS. The documentation will be done by filling out a SOP Deviation Form (see Appendix A) to petition a SOP change or to explain the deviation.

I.3 Reactor Operating Parameters

The reactor will be operated under conditions and limitations as set forth in the technical specifications, Appendix A to License R-103.

I.4 Administrative Policies

I.4.1 Standing Orders

New procedures prior to becoming part of these Standard Operating Procedures, procedures to be in effect for a short period, and special instructions relating to operation of the reactor, will be issued as Standing Orders. All effective Standing Orders, as well as a listing of current orders, will be maintained in a log in the reactor control room. Standing Orders that are no longer applicable or that are incorporated into the Standard Operating Procedures will be canceled and removed from the log. All Standing Orders will be approved by signature of the Reactor Manager or his authorized delegate.

## I.4.2 General Operating Policies

### A. Safety

Safe operation of the reactor will take precedence over other considerations.

### B. Supervisory Authority

The importance of one coordinator for all reactor activities is recognized for safety and effective control of operation. The Reactor Manager will have complete operating authority over all activities related to reactor operation.

The Shift Supervisor is the Reactor Manager's delegated representative on shift and is given the authority to direct the activities (both licensed and unlicensed) related to reactor operation during his duty shift.

Whenever the Shift Supervisor is absent, a Senior Operator shall assume the lead Senior Operator position. The lead Senior Operator is delegated the Shift Supervisor's authority and responsibility for shift activities during the Shift Supervisor's absence. **If the Shift Supervisor is out of the control room for an extended period of time, the lead Senior Operator may be authorized to make routine control room decisions. However, the Shift Supervisor should be consulted for non-routine situations and kept informed. The delegation to the lead Senior Operator will be left to each Shift Supervisor.**

Any SOP reference to Shift Supervisor applies to the lead Senior Operator when the Shift Supervisor is absent from his duty shift.

### C. Operating Crews

1. The minimum number of reactor operators for reactor operation will be two licensed persons. One of these will be licensed as a Senior Reactor Operator. One exception is allowed for family emergencies. In this case, one Senior Reactor Operator may operate the reactor with another knowledgeable person present in the facility, which exceeds Technical Specification 6.1.i requirements. This mode of operation shall be documented in the console log and minimized by calling in an additional licensed operator. The Reactor Manager or Operations Engineer should be informed as soon as possible.

2. There will be one licensed operator in the control room at all times whenever the reactor is not considered secured, as defined in Part 1.20 of the Technical Specifications. When the reactor is shutdown but not secured, the control room boundary can be expanded to include the bridge area during refueling or maintenance activities.

D. Console Log

A log will be maintained in the control room by the reactor operator providing a detailed diary of reactor operation.

E. Corrections to Console Log, Nuclear and Process Data and Routine Patrol Sheets

Any corrections to a log entry or data sheet will be done by a single line through the incorrect entry, plus the initials of the person making the change. If the correction is made at a later date, the person making the correction will initial and date the change.

F. Changing Reactor Reactivity

Operations affecting changes in core reactivity, other than normal steady state power control, i.e., refueling, startup, etc., will be directly supervised by a Senior Operator.

G. Malfunction of Reactor Systems While at Power

Any malfunction or abnormal operation of a control or reactor system shall be immediately brought to the attention of the Shift Supervisor. The decision as to whether to continue operation of the reactor depends upon the severity of the malfunction. It remains with the Shift Supervisor as to what immediate action needs be taken. However, the duty operator is authorized, in the absence of the Shift Supervisor from the control room, to place the reactor in a safe shutdown mode if he deems it necessary. It is important that the reactor systems, while the reactor is critical, not be experimented with, or reactor control systems tested, unless permission to do so is explicitly granted by either the Reactor Manager or his designated representative.

## I.4.2 General Operating Policies (cont'd)

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### H. Maintenance Performed on Reactor Systems

All maintenance on reactor and license related systems and equipment will be reviewed by the Shift Supervisor to ensure operability of these systems prior to reactor operation.

### I. Maintaining Active Operator Status

1. Actively performing the functions of an Operator or Senior Operator ] means that an individual has a position on the shift crew that requires the individual to be licensed as defined in 10 CFR 55, and that the individual carries out and is responsible for the duties covered by that position.
2. If an Operator has not performed licensed duties a minimum of four ] hours on shift per calendar quarter, before resumption of licensed activities, the Reactor Manager shall certify that the qualifications and status of the Operator are current and valid, and that the Operator has completed a minimum of six (6) hours of shift functions under the direction of a Senior Operator before returning to active status.

### J. Reactor Operating Parameters

The reactor shall be operated in strict accordance with the Reactor License R-103 and the operating limits in Tables III and IV.

## I.4.3 Startup

### A. Startup Following a Scram

The reactor will not be started up following a scram until the cause of the scram has been determined and safe corrective action taken. If, after thorough investigation, the cause of the unscheduled reduction is power cannot be determined and all systems are found to be normal, the reactor may be started up with the approval of the Reactor Manager or his authorized delegate.

- A. The top portion of the RWP will be prepared by the Job Supervisor and Health Physics. The time and date spaces should contain the supervisor's estimate of the duration of the job (0800-2400 September 2, 1988; 0000-2400 September 10-12, 1988, etc.). The Job Supervisor should be as specific as possible in describing the job. This will aid Health Physics in determining the protective measures necessary.
- B. Health Physics will assign a number to the RWP and conduct the necessary surveys and determine the protective measures necessary for the job. Health Physics will complete the remainder of the RWP indicating the survey results and the protective measures required. Health Physics will then sign and date the RWP, and obtain approval signature from the Job Supervisor and information signature from the Shift Supervisor, if appropriate.
- C. The Job Supervisor will provide Health Physics with the names of personnel expected to work under the RWP prior to the start of the job. Each person performing work under the RWP shall be informed of the required radiation controls and shall acknowledge being informed by signing on their designated signature line. Health Physics will have available the approved RWP at the job site for ready reference by the personnel doing the work.
- D. When the job has been completed and the job site has been cleaned up and decontaminated, the Job Supervisor will deliver the RWP to Health Physics. Health Physics will verify that the job site is clean and decontaminated, and will record estimated dose for each person involved. Health Physics will terminate the RWP and maintain it in an RWP file. Any person who signed approval or any supervisor can terminate the RWP by signing the termination block. Health Physics must be notified if the RWP is terminated by someone other than a member of the Health Physics Group.

I.4.9 Radiation Safety

The Shift Supervisor is directly responsible for the overall safety of personnel on his shift and indirectly responsible for all personnel whose safety may be affected by activities conducted under his supervision. Radiation safety is a very important part of this responsibility. It should not be construed that surveys, monitoring, or other measurements to check for contamination or radiation are to be made by operations personnel, but rather that the Shift Supervisor is responsible to ensure that through coordination with the Health Physics personnel, adequate protection is provided for evolutions conducted during his shift.

I.4.10 Physical Protection of Special Nuclear Materials

In accordance with 10 CFR 73, special requirements must be met in safeguarding Special Nuclear Material. The safeguards provided and the procedures applicable to maintaining the security of Special Nuclear Materials are contained in the facility Security Plan and Security Procedures.

I.4.11 Equipment Tag Out Procedure ]

I.4.11.1 Purpose

The purpose of the tag out system is to prevent injury to personnel and/ ]  
or damage to equipment. **Campus Facilities also has its own tag ]**  
**system. When they work on equipment at MURR, with the Shift ]**  
**Supervisor's permission, their tag system serves this same ]**  
**purpose and shall be honored. All Campus Facilities Tags are to ]**  
**be accompanied by MURR tags. ]**

I.4.11.2 Types of Tags

A. Red Tags

Red tags will be used to identify equipment which, if operated, could present a hazard to personnel. The tag will also contain information pertaining to the reason for the tag.

B. Yellow Tags

Yellow tags will be used to identify equipment which, if operated, could present a hazard to that or other equipment. The tag will also contain information pertaining to the reason for the tag.

### I.4.11.3 Equipment Tag Out

#### A. Tag Out Log

1. The tag out log will be maintained in the control room by the on-duty Shift Supervisor.
2. The tag out log will be made up of six sections:
  - a. Monthly Audit
  - b. Tag Out Instructions
  - c. Index Record
  - d. Active Tag Out Sheet Section
  - e. Inactive Tag Out Sheet Section
  - f. Blank Sheet Section

#### B. Performing a Tag Out

1. A tag out will be performed by facility personnel with the approval of the on-duty Shift Supervisor.
2. The on-duty Shift Supervisor must approve the hanging or removal of ALL tags.
3. In the event that a tag is discovered missing, the Shift Supervisor will be informed immediately. The Shift Supervisor will determine corrective action.

#### C. Tag Out Audit

A tag out audit will be performed monthly as scheduled by a predetermined DUE DATE. The person performing the Audit will:

1. Inventory all active tags.
2. Note any incorrect or missing tags.
3. Sign and date the monthly Audit sheet.
4. Discard the old inactive tag out sheets.

## MURR TAG OUT INSTRUCTIONS

### Tag Out:

1. Obtain the Shift Supervisor's permission to hang tag(s).
2. Complete the MURR Tag Out Index Record. For tag out use next sequential number (self-explanatory).
3. Complete both sides of the MURR Tag Out Sheet (self-explanatory).

### Tag Removal:

1. Obtain the Shift Supervisor's permission to remove tag(s).
2. Complete the MURR Tag Out Sheet (move to the inactive section if all tags are cleared).
3. If all tags are cleared, complete the MURR Tag Out Index Record.

### Temporary Tag Removal: (for example, to test equipment)

1. Obtain the Shift Supervisor's verbal permission to temporarily remove tag. ]
2. The Shift Supervisor will authorize a MURR staff member to temporarily remove the tag. ]
3. After testing, the staff member will report results of test to Shift Supervisor who will decide if tag should be cleared or re-hung. ]

- III.8 Check of Process Radiation Monitors 1
- III.8.1 Operational Check of Secondary Coolant and Fission Product Monitors respectively. 1
- A. Lower alarm setpoint until annunciator alarms.
  - B. Place level set switch up and adjust alarm setting to 10k cpm + 10%.
  - C. Lower alarm setpoint until annunciator alarms.
  - D. Place level set switch up to and adjust alarm setting to 12k cpm + 10%.
- III.8.2 Operational Check of Stack Monitor 1
- A. The operator conducting the test in the West Tower shall establish communication with the control room via the intercom
  - B. Place the mode switch for the iodine detector in the "T" (test) position.
  - C. Verify that the recorder pen indicates 3600 cpm + 10%, and that the stack monitor high activity annunciation is received. Also verify that the local meter reads within 10% of the test reading marked on the meter face.
  - D. Return the iodine mode switch to the "N" position.
  - E. Press the "reset" button until the iodine meter and recorder readings return to normal, do not drive them to the downscale position. Reset the annunciator.
  - F. Place the mode switch for the particulate/gas monitor in the "T" position.
  - G. Verify that the particulate recorder and gas recorder pens indicate 3600 cpm + 10% and that the stack monitor high activity annunciation is received. Also verify that the local meter reads 3600 cpm + 10%.
  - H. Return the particulate mode switch to "OP" position.
  - I. Press the "reset" button until the particulate meter and recorder readings return to normal; do not drive it to the downscale position. Reset the annunciator.
  - J. Test the low flow alarm in the control room by securing the blower.
  - K. Return the blower switch to "on", verify "high" and "low" alarms cleared.

### III.9 Area Radiation Monitoring System

The area radiation monitoring system will be in operation continuously and is to be turned off only during maintenance on the system. When handling samples, or during maintenance, place the Bridge Upscale Switch in the upscale position. Ensure Bridge Upscale Switch is returned to normal position after handling samples.

The station trip points shall be set as follows:

|            |                   |  |
|------------|-------------------|--|
| Station 1  | BP North Wall     | 2 X acceptable background                    |
| Station 2  | BP West Wall      | 2 X acceptable background                    |
| Station 3  | BP South Wall     | 2 X acceptable background                    |
| Station 4  | Exhaust Plenum    | 1 mr/hr or 10 X normal operating background  |
| Station 6  | Bridge ALARA      | 300 mr/hr alert<br>10K mr/hr alarm/trip      |
| Station 7  | Bridge            | 50 mr/hr or 10 X normal operating background |
| Station 8  | Nuclepore         | 2 X normal operating background              |
| Station 9  | Fuel Vault        | 2 X normal operating background              |
| Station 10 | Room 114          | 2 X normal operating background              |
| Station 11 | Exhaust Plenum #2 | 1 mr/hr or 10 X normal operating background  |

At least once a month for stations 4, 6, 7 and 11, and once a quarter for the remaining stations, the system will be checked according to the following procedure:

NOTE: GREEN Lamp serves as Normal light and Check Source actuating switch (push to actuate source).

AMBER Lamp serves as Alert alarm (push to reset).

RED Lamp serves as High alarm (push to reset). The alert has been set up on all ARMS units except for the **Bridge ALARA**.

- A. At station 1, operate the check source pushbutton and verify that when trip point is reached, the RED alarm lamp lights at the Electronic Channel, and the RED alarm lamp lights and the AUDIBLE alarm sounds at the Remote Alarm Unit.
- B. Repeat step A for Stations 2, 3, 8, 9 and 10.

## VI.4 Shutdown of the Secondary System (cont'd)

]

- B. Verify that system flow recorder indicates no flow and that the chiller pump, P-4, has automatically started to provide coolant flow to the chiller unit.
- C. Turn off cooling tower fans.

VI.5 Draining and Filling the Secondary System Heat Exchanger and Piping  
This section has been moved to SMP-21.

## VI.6 Secondary Water Treatment Procedures

### VI.6.1 Secondary Water System Responsibility

The responsibility of the secondary water treatment is within the operations group of the reactor, with two individuals given prime responsibility to learn and be closely associated with the total operation. The secondary water treatment system is designed to minimize corrosion, deposition, microbiological growth, and other major chemical problems which are present in the secondary cooling water system.

### VI.6.2 Secondary Water Conductivity Control

To control conductivity (total dissolved solids), water is sampled and monitored by the conductivity unit. If the conductivity is greater than the system setpoint, an automatic blowdown is initiated. The freshwater ]  
makeup, which replaces the water lost through the blowdown, lowers the ]  
conductivity.

### VI.6.3 Secondary Water pH Control

To control pH, water is sampled and monitored by the pH unit located in the tunnel entrance of room 114. If the pH increases above the system setpoint, the acid injection valves automatically open and acid is gravity fed into the tower sump. The acid used is concentrated sulfuric acid supplied from the 250-gallon day tank in the cooling tower.

### VI.6.4 Sample Paths for pH and Conductivity

- A. During normal operation of the secondary system, the automatic pH and conductivity control units receive their sample water through valves S104 and S151.

#### VI.6.4 Sample Paths for pH and Conductivity (cont'd)

]

- B. During operation of the secondary system with the air conditioning units secured and isolated, close S104 and open S103. This provides a representative sample for these units to control pH and conductivity.
- C. The pH and conductivity units shut down when secondary pumps (P-1, P-2, and P-3) are secured.

#### VI.6.5 Secondary Water Corrosion Prevention

- A. The prevention of corrosion in the secondary system is accomplished by automatic addition of a corrosion inhibitor.
- B. These chemicals are fed automatically by a metering pump system based on makeup flow.

#### VI.6.6 Secondary Silt, Algae and Mud Control

Silt and mud buildup is controlled by the feeding of a chemical silt dispersant to the cooling tower basin. The dispersant is added to ensure solids remain suspended a sufficient amount of time to allow the secondary blowdown to remove them from the system. This reduces secondary conductivity and minimizes the buildup of silt in low flow areas, a fouling condition. Microbiological and algae growth is controlled by the addition of two microbiocides/algaecides. The addition frequency is determined by weather conditions and reactor operations.

#### VI.7 Secondary System Operation on Maintenance/Refueling Days

Start either P-1, P-2, or P-3 and run as necessary to maintain primary and ] pool system temperatures.

NOTE: Fans may need to be run also to maintain proper cold deck temperatures.

## VII .3 Emergency Power System

### VII.3.1 Testing of the Emergency Power System

At least once a week the emergency generator will be started automatically and permitted to run for at least 30 minutes. This event will be noted in the console log. A green light mounted on a side panel in the control room will energize whenever the emergency generator is running. In addition to this, the emergency generator will be operated for a period of about 30 minutes prior to each startup after a shutdown exceeding 24 hours. *On a quarterly basis, commercial power to the auto transfer switch is interrupted at unit substation B in order to allow the emergency generator to start and immediately assume its electrical loads (CP-17).*

A modified load test (CP17) shall precede and a full load test (CP-17) shall follow any work on the emergency generator except for routine maintenance that has been proven to not cause a problem.

### VII.3.2 Manual Start Procedures

*Manual starting of the diesel generator under no load conditions is accomplished as follows: Perform normal prestart checks (oil, fuel, coolant level, etc.). Lift and hold the MANUAL START switch at the START position, and press and hold the CRANK switch. The starter will begin cranking and after a few seconds the engine should start. When the engine starts, release both switches. If the engine does not start after 20 to 60 seconds of cranking, release both switches, wait for two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt at starting, refer to the troubleshooting section of the technical manual. After starting, check the normal operating indications as: RPM ~ 1800, oil pressure ~ 38 lbs., oil temperature ~ 150°, and water temperature ~ 180°. The alarm panel will indicate early warning and shutdown alarms.*

VII.3.3 To Stop Engine

To Stop engine, place the MANUAL START switch to the OFF position-- where it should remain for normal operation.

VII.3.4 Deleted

VII.4 Reactor Demineralizer System

VII.4.1 Normal Operation

Normally there are four mixed resin beds in the system at one time with two beds on-line, one in standby or depleted and one in the storage tank for pre-shipment decay. The normal flow path is via a 50 gpm pump, system inlet filters, down through the DI bed, and through system outlet filters. The outlet valve of the system inlet filter is used as a throttling device with the bypass valve always remaining closed. Although regeneration of a bed is possible, single life pre-generated beds are normally used in this system. If regeneration of DI beds is necessary, the procedures to perform this task are incorporated into SMP-16.

VII.4.1.1 Placing Standby Cleanup Bed on Reactor Service

CAUTION must be exercised to prevent a reactor loop low pressure scram from occurring during this procedure!

- A. Check the DI Resin Log for the status of the affected bed(s).
- B. Ensure all valves on standby DI column are closed.
- C. Open valve DI-2 slightly on standby column to allow pressure to equalize, then open fully
- D. Open standby column DI-5 to place in parallel with on-line column.
- E. Remove the depleted bed from service by shutting DI-2 and DI-5 on depleted column.
- F. Transfer the depleted bed H3 water to the DCT. (see VII.4.2.7)
- G. Record the transaction in both the DI Resin Log and Console Log.

#### VII.4.1.2 Placing Standby Cleanup Bed on Pool Service

- A. Check the DI Resin Log for the status of the affected bed(s).
- B. Ensure all valves on standby DI column are closed. ]
- C. **Open valve DI-1 slightly on standby column to allow pressure to equalize, then fully open.** ]
- D. Open standby column DI-4 to place in parallel with on-line column. ]
- E. Remove the depleted bed from service by shutting DI-1 and DI-4 on depleted column. ]
- F. Transfer the depleted column H3 water to DCT. (see VII.4.2.7) ]
- G. Record the transaction in both the DI Resin Log and Console Log. ]

#### VII.4.2 Resin Transfers

Demineralized water will be used for all resin manipulations. The T-300 flow booster pump should be used anytime gravity feed does not supply adequate flow.

##### VII.4.2.1 Resin Loading

To load the resins into the regenerator, first drain most of the excess water from the regenerator to allow an increased educting flow rate, then educt the cation (5 cubic feet), next educt the anion (7 cubic feet). The cation level should be just above the acid header. To properly educt resin into the regenerator, enough water must be added to the resin to create a slurry mixture. To educt:

- A. **Ensure the proper DI system valve line-up exists per the DI System Valve Line-Up Checksheet.** ]
- B. Connect the quick-disconnect hose to the DI supply and open the T-300 valve RE-89. ]
- C. Place a barrel under the eductor pipe to contain the resin slurry to be educted.
- D. Open valves RE-7, RE-18, at the regeneration station.
- E. Open RE-15, check closed RE-16.
- F. Open vent valve RE-9, to allow the regenerator to drain.
- G. Open RE-13, place the resin suction line in the resin and open RE-12 to add water to make a slurry.

#### VII.4.2.1 Resin Loading (cont'd)

- H. When water level is sufficient, open R-5 to begin eduction. Stir the resin while it is being educted. When water issues from vent valve RE-3, close RE-13 to allow excess water to drain off. Wait approximately 10-15 minutes. Open RE-13 to continue eduction.
- I. Repeat step H until desired level of resin is obtained.
- J. When water issues from vent valve RE-9, close RE-13, then close RE-15.  
NOTE: At this step all resins are covered with water. DO NOT allow resins to dry out; this can destroy them.
- K. Close remaining valves, R-5, RE-12 (inside DI room) and RE-7, RE-9, RE-18, RE-89 (at regeneration station).
- L. Open RE-68 to depressurize the flexible hose, then shut RE-68.
- M. Record the transaction in both the DI Resin Log and Console Log.

#### VII.4.2.2 R-200 Resin Dump

- A. Obtain a RWP.
- B. **Ensure the proper DI system valve line-up exists per the DI System Valve Line-Up Checksheet.**
- C. Place the resin drying barrel under the dump pipe.
- D. Ensure the flexible hose is connected to the DI water supply, then open RE-89 and RE-18.
- E. Open RE-25 compressed air isolation valve and set the regulator to 60 lbs.
- F. Open RE-10 to pressurize R-200 to 60 lbs., then close RE-10.
- G. Slowly open RE-11 to dump resin. You may, at sometime during the dumping, need to add water to R-200. Use RE-3 for this purpose.
- H. When dumping is complete, close RE-11, and RE-25, back off on the regulator, and vent the air system.
- I. Open RE-9 to vent any remaining pressure.
- J. Open RE-3 to fill R-200.
- K. When full, close RE-3, RE-9, RE-18, and RE-89 (T-300 to DI-200 isolation valve.)
- L. Open RE-68 to vent the pressure in the flexible hose, then close RE-68.
- M. Record the transaction in both the DI Resin Log and Console Log.
- N. Close out the RWP.

### VII.4.2.3 Transferring Resin from a DI Column to R-200

- A. Ensure that waste tank #2 has the capacity to accept the transfer water. ]
- B. Check the DI Resin Log for the status of the affected bed(s).
- C. **Ensure the proper DI system valve line-up exists per the DI System Valve Line-Up Checksheet.** ]
- D. Ensure the flexible hose is connected to the DI water supply, then open RE-89 and RE-18. ]
- E. Open the RE-25 compressed air isolation valve and set the regulator to the maximum pressure available.
- F. Perform an H3 water transfer to the DCT, if it has not already been done on this bed. (see VII.4.2.7)
- G. **Add water by opening DI-3, DI-8, and R-2.** ]
- H. **When full, close DI-3 and R-2.** ]
- L. Open DI-9 and DI-13, and **drain bed** for four minutes. ]
- J. Close DI-9 and DI-13. ]
- K. Open DI-7 fully until the sparge begins. You may have to close DI-7. ]  
Wait until the pressure in the column vents off and then quickly open DI-7 several times before the hard packed resin breaks loose. When it does, throttle back to the most vigorous sounding sparge and continue for at least ten minutes. If you do not hear a good sparge, water may have to be added.
- L. When completed, close DI-7 and DI-8. ]
- M. Open DI-3, DI-6, R-1, RE-7, and RE-16. ]
- N. To start the resin transfer, open R-2 and observe the bullseye for resin movement. The DI water booster pump may have to be used for adequate flow. ]
- O. After the transfer is completed, close R-2, RE-16, RE-7, R-1, DI-3, DI-6, RE-18, and RE-89 (T-300 to DI-200 isolation valve). ]
- P. Close RE-25, back off on the air regulator and vent the air system. ]
- Q. Open RE-68 to vent the pressure in the flexible hose, then close RE-68. ]
- R. Record the transaction in both the DI Resin Log and the Console Log. ]

VII.4.2.4 Transfer of Resins from R-200 to Standby DI Column

- A. **Ensure the proper DI system valve line-up exists per the DI System Valve Line-up Checksheet.** ]
- B. Check the DI Resin Log for the status of the affected bed(s).
- C. **Ensure the flexible hose is connected to the DI water supply, then** ]  
open RE-89 and RE-18.
- D. Open RE-3, DI-13, and "ON THE STANDBY COLUMN" open DI-3 and DI-9.
- E. Open R-3 to start the transfer. Observe the resin flow in the bullseye. The DI water booster pump may have to be used to achieve adequate flow.
- F. When transfer is complete, close DI-3.
- G. Open DI-8 and **drain bed** for four minutes, then close DI-9. ]
- H. Open RE-25 and set the air regulator to 45 lbs.
- I. Slowly open DI-7 to achieve a 10-15 cfm flow rate or a rate which gives the most vigorous sounding sparge and sparge for at least ten minutes.
- J. When completed, close DI-7 and open DI-3 to fill the tank.
- K. When water overflows through the vent line, close DI-3.
- L. Close DI-13, DI-8, R-3, RE-18, RE-3, RE-25, and back off on the regulator and close RE-89 (T-300 to DI-200 isolation valve).
- M. Open RE-68 to vent the pressure in the flexible hose, then close RE-68.
- N. Record the transaction in both the DI Resin Log and the Console Log.

VII.4.2.5 Transfer of Resin from DI Column to the Storage Tank

- A. **Ensure that waste tank #2 has the capacity to accept the transfer** ]  
water.
- B. Check the DI Resin Log for the status of the affected bed(s).
- C. **Ensure the proper DI system valve line-up exists per the DI** ]  
**System Valve Line-Up Checksheet.** ]
- D. **Ensure the flexible hose is connected to the DI water supply, then** ]  
open RE-89 and RE-18.
- E. Open the RE-25 compressed air isolation valve and set the regulator to the maximum pressure available.
- F. Perform an H3 water transfer to the DCT, if it has not already been done on this bed. (see VII.4.2.7)

- VII.4.2.5 Transfer of Resin from DI Column to the Storage Tank (cont'd) ]
- G. Open DI-3, DI-8 and R-2 until water comes out vent. ]
  - H. Close R-2 and DI-3. ]
  - L. Open DI-9 and DI-13 and **drain bed** for four minutes. ]
  - J. Close DI-9 and DI-13. ]
  - K. Open DI-7 fully until the sparge begins. You may have to close DI-7, ]  
wait until the pressure in the column vents off and then quickly open ]  
DI-7 several times before the hard packed resin breaks loose. When it ]  
does, throttle back to the most vigorous sounding sparge and continue for ]  
at least ten minutes. If you do not hear a good sparge, water may have ]  
to be added. ]
  - L. When completed, close DI-7 and DI-8. ]
  - M. Open DI-3, DI-6, RS-3, RS-5 and DI-13. ]
  - N. To start the resin transfer, open R-2 and observe the bullseye for ]  
resin movement. The DI water booster pump may have to be used for ]  
adequate flow. ]
  - O. After the transfer is completed, close R-2, DI-13, DI-6, DI-3, RS-3, ]  
RS-5, RE-18 and RE-89 (T-300 to DI-200 isolation valve). ]
  - P. Close RE-25, back off on the air regulator and vent the air ]  
system. ]
  - Q. Open RE-68 to vent the pressure in the flexible hose, then close RE-68. ]
  - R. Record the transaction in both the DI Resin Log and the Console Log. ]

- VII.4.2.6 Transfer of Resin from the Storage Tank to R-200 ]
- A. Ensure that waste tank #2 has the capacity to accept the transfer ]  
of water. ]
  - B. Check the DI Resin Log for the status of the affected bed(s). ]
  - C. **Ensure the proper DI system valve line-up exists per the DI ]  
System Valve Line-Up Checksheet.** ]
  - D. Ensure the flexible hose is connected to the DI water supply, then ]  
open RE-89 and RE-18. ]
  - E. Open the RE-25 compressed air isolation valve and set the regulator to ]  
the maximum pressure available. ]
  - F. **Fill storage tank by opening RS-1, RS-2, and R-2 until water ]  
comes out vent.** ]

- VII.4.2.6 **Transfer of Resin from the Storage Tank to R-200 (cont'd)** ]
- G. **Close R-2 and RS-2.** ]
  - H. Open RS-5 and DI-13 and **drain bed** for four minutes. ]
  - I. Close RS-5 and DI-13. ]
  - J. Open RS-4 slowly to achieve the best sounding sparge and allow it to sparge for ten minutes. ]
  - K. When completed, close RS-4 and RS-1. ]
  - L. Open RS-2, RS-7, R-1, RE-7 and RE-16. ]
  - M. Open R-2 to start the transfer. Observe the resin flow in the bullseye. ]  
The DI water booster pump may have to be used to achieve adequate flow.
  - N. When transfer is complete, close R-2, R-1, RS-2, RS-7, RE-7, RE-16, ]  
RE-18 and RE-89 (T-300 to DI-200 isolation valve).
  - O. Close RE-25, back off on the air regulator and vent the air system. ]
  - P. Open RE-68 to vent the pressure in the flexible hose, then close RE-68. ]
  - Q. Record the transaction in both the DI Resin Log and the Console Log. ]

VII.4.2.7 Transferring Tritiated (3H) Water to the DCT

- A. Check the DI Resin Log for the status of the affected bed(s).
- B. **Ensure the proper DI system valve line-up exists per the DI System Valve Line-Up Checksheet.** ]
- C. Ensure the operability of the DCT system by pumping down the collection tank prior to this operation.
- D. Ensure the flexible hose is connected to the DI water supply, then open RE-89 and RE-18.
- E. Open RE-25.
- F. Open DI-9 AND DI-14.
- G. Open DI-10 (DI-200) or DI-11 (DI-201) or DI-12 (DI-202), whichever is applicable to this operation, to start the water transfer.
- H. When tank is empty, close DI-10, DI-11 or DI-12 (whichever is applicable) and DI-9.
- I. Open DI-8, R-2 and DI-3 to fill the tank with water.
- J. When full, close DI-3 and DI-8.
- K. Repeat steps F through J so that you have completed two water transfers and fills. The bed will be left in a filled condition. Use CAUTION to ensure that you do not overflow the DCT. ]
- L. When completed, close DI-14, R-2, RE-25, RE-18 and RE-89 (T-300 to DI-200 isolation valve).
- M. Open RE-68 to vent pressure in the flexible hose, then close RE-68.
- N. Record the transaction in both the DI Resin Log and the Console Log.

II.4.3 Providing DI Water to T-300 or the Facility Demineralized Water Tanks ] ]

DI water may be sent to T-300 or the facility DI water tanks with or without the use of the reverse osmosis unit as a DI-300 makeup supply. Due to the fact that DCW, after passing through the R.O. Unit, is much more pure than raw DCW, the R.O. Unit is normally utilized to prolong the life of the DI-300 resin regeneration. However, there are provisions for bypassing the R.O. Unit when sending DI-300 water directly to DI-200 (see VII.4.3.3).

VII.4.3.1 Providing DI Water to T-300 or the Facility DI Water Tanks with Reverse Osmosis Makeup ]

A Culligan (Polishing) bed is used to augment the R.O. unit.

- A. Open: ]
  - 1. RE-31 if supplying water to T-300. ]
  - 2. DI-21 if supplying water to facility DI water tanks. ]
- B. Place product water valve RO-10 to the DI water system position. ]  
NOTE: The handle points in the direction of the open port.
- C. Check open the following R.O. Unit valves: RO-1, RO-2, RO-5, RO-7, RO-8, RO-9 and RO-13.
- D. Open outlet valve (RO-11) from Culligan bottles.
- E. Open DI-5.
- F. Turn conductivity meter to "ON" and place auto valve switch to "AUTO" (first auto valve should open). If sending to T-300, place high level cutout switch to cutout if high level shutdown exists in facility DI tanks. ] ]
- G. Push the R.O. Unit start button.
- H. Push reset button under conductivity meter (second auto valve should open). There should be a 3 to 6 second delay before R.O. Unit starts. (Pressure should come up to 190-200 psig.)  
CAUTION: If valves do not open, the conductivity is at or above alarm setpoint. Place normal/bypass switch to "BYPASS".
- I. Flush R.O. Unit through DI-5 until conductivity falls below alarm setpoint.
- J. Open auto valve isolation valve (DI-17) and shut DI-5.
- K. Place normal/bypass switch to "NORMAL" if required.
- L. Fill out the DI water log.

Normally, the water inlet temperature will not require adjustment and is set at approximately 25 to 30°C. Allow at least 30 minutes of running time to stabilize temperature prior to determining if an adjustment is needed.

TO SECURE SENDING WATER

- A. Push the R.O. Unit off button.
- B. Place auto valve switch to "CLOSE." Turn conductivity meter to "OFF" (both auto valves should be closed).
- C. Shut auto valve isolation valve (DI-17).
- D. Shut Culligan bottles discharge valve (RO-11).
- E. Place product water valve RO-10 to the flush or drain position.
- F. Shut: ]
  - 1. **RE-32 if supplying water to T-300.** ]
  - 2. **DI-21 if supplying water to facility DI water tanks.** ]

CAUTION: The following valves should be left open while the unit is OFF:

|      |       |
|------|-------|
| RO-2 | RO-7  |
| RO-5 | RO-8  |
| RO-1 | RO-9  |
| RO-6 | RO-13 |

- G. Fill out the DI water log.

When the unit is not in use, DO NOT UNPLUG, PLACE IN STANDBY ONLY. DO NOT SECURE SUPPLY WATER.

NOTE: If for any reason the unit must be turned off or the supply water secured, this condition MUST NOT exist for more than 60 hours or damage will occur to the filter membranes (see technical manual #476 for details).

No regular maintenance is required to operate this unit. For any repair or maintenance, refer to the technical manual.

VII.4.3.2 Providing DI Water to T-300 Without Reverse Osmosis Unit Makeup Transferred to SMP-22.

VII.4.3.3 Providing DI Water to DI200 Units Using R300 Bed Transferred to SMP-22.

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- C. Material which may be irradiated in the p-tube system includes water, plant and animal tissue and fluids, bone, air filters, soils, rocks, soil extracts, coal, paper, meteorites, fibers, dried paint, safe insulation and glass. Pure elements, alloys and compounds not exempted in D below may also be irradiated subject to the activity limitations in A.
- D. Unless it is specifically authorized in the experimenter's RUR, the following materials will not be irradiated in the p-tube system:
- E. 1. Natural uranium; ]
2. Special nuclear materials as defined in Title 10, Part 70, Paragraph 70.4m of the Federal Code of Regulations (i.e., plutonium, uranium-233, or uranium enriched in isotope 233 or 235);
3. Pure elements: Li, Na, K, Rb, Cs, Ca, Sr, Ba, Hg, Os, H, O, F, Ne, Ar, Kr, Xe, and P;
4. Compounds:  $\text{NH}_4\text{NO}_3$ ,  $\text{CaC}_2$ ,  $\text{CaO}$ , perchlorates, permanganates,  $\text{Na}_2\text{O}$ , and  $\text{Na}_2\text{O}_2$ ;
5. Materials which chemically react with water to produce undesirable quantities of heat and pressure;
6. Any explosive, flammable, combustible, or toxic materials.
- F. Capsules may be run shielded with cadmium or boron (as ] boron, BC, or BN) but weight and time are restricted due to the heat generated and their reactivity effect on the reactor. The experimenter shall take measures to insure the heat generated can be dissipated without causing damage to the rabbit or sample. The following limitations apply to shielded capsules in addition to the activity limits of Section VIII.3.2.A:

### VIII.3.2. Sample Limitations (cont'd)

1. The authorized p-tube user will inform the control room he/she is going to run shielded capsules and will insert the rabbit so that the cap is on top when the rabbit is in the reactor.
  2. Cadmium shielded capsules:
    - a. 5 or less grams of cadmium may be run for up to 30 minutes.
    - b. 50 or less grams of cadmium may be run for up to 10 seconds in Row 1 or 20 seconds in Row 2.
  3. Boron shielded capsules:

NOTE: The weight limit is only on the boron, i.e., the carbon weight in BC does not count towards the weight limit.

    - a. The **single** boron shielded capsule with between 10 to 15 grams of boron may be run for up to **15** seconds in Row 1 or up to 20 seconds in Row 2.
    - b. The **double boron shielded capsule with between 15 and 20 grams of boron may be run for up to 10 seconds in Row 1.**
- G. Except for the boron or cadmium shielded samples, the controlling factor for determining the weight and time limits of a sample to be irradiated in the p-tube is the activity limitation of Section A. If the activity limits do not further restrict a sample's size, the following weight limits shall apply:
1. For irradiation times up to 30 minutes, the maximum weight of irradiated materials in one rabbit will be 2 grams with two exceptions:
    - a. A maximum of 10 grams of water or dried feces;
    - b. Only 1 mg of chemical compounds in solution.
  2. For irradiation times of 30 minutes to 1 hour, the maximum weight of irradiated materials in one rabbit will be 1 gram with two exceptions:
    - a. A maximum of 10 grams of water or dried feces;
    - b. Only 500 mg of chemical compounds in solution.

The weight limits above do not include the weight of the rabbit, polyethylene vial, or packing, or the cadmium (or other metal) shields.

The maximum irradiation time for most samples will be 30 minutes for power levels > 5 MW. Hair, fibers, paint, air filters and flux monitors may be irradiated for a maximum of 2 hours at power levels > 5 MW. The following additional limitations shall apply for irradiations > 10 minutes:

1. Primary encapsulation will be heat-sealed high-density polyethylene vials (Holland vials).
2. Liquid samples may be irradiated for up to 30 minutes provided pin holes are punched in the top of the polyethylene vial to relieve pressure.

Deviations from the above weight and time limitations must be specifically authorized in the experimenter's RUR.

### VIII.3.3 Rabbit Limitations

- A. The only type of rabbit which may be used in the p-tube system is the high density rabbit. This type of rabbit will be used for all irradiations (see Section VIII.3.2.B). Each high density rabbit will be limited to six insertions not to exceed a total irradiation time of one hour or a single insertion not to exceed a total of two hours.

EXCEPTION: Each high density rabbit, used for 5 second irradiations under RUR 254, is authorized to be run a total of 15 times.

To account for the irradiation history of high density rabbits, the experimenter will place one mark with a marking pen on the high density rabbit for each insertion up to and including 10 minutes. For irradiations longer than 10 minutes, a mark will be placed on the rabbit for each 10 minute period or fraction thereof. For example, if a rabbit is irradiated for 25 minutes, it will receive 3 marks. When a rabbit has received 6 marks, it will be discarded. Each rabbit must be examined for cracks or other signs of potential failure before it is used.

- B. Only high density modified rabbits may be used in the p-tube ] system to run boron shielded rabbits. ]

#### VIII.3.4. Sample Irradiation Procedures

- VIII.3.4.1 When experimenter **has** met the requirements of VIII.3.3 and is ready to run experiment, **he/she** shall first make certain that the P-tube system for the desired irradiation position is not in use; i.e., the system "in use light" should be off, **and** then call the reactor control room giving:
- A. Name
  - B. Laboratory room number
  - C. Experiment file number
  - D. Project number
  - E. Length of time the sample will be in reflector
  - F. **If the irradiations are to be done under the Serial Mode, the experimenter must advise the operator that such is the case.**
  - G. **When operating in the Serial Mode, the experimenter must contact the control room in the case of any of the following:**
    - a. Any problems with the dispatch or receipt of a rabbit.
    - b. Any interruption or delay of the intended cycle such that the blowers could be secured if the operator deems it necessary.
    - c. Any significant change in sample or standard matrix or use of, or discontinuation of use of, a boron capsule.
    - d. Any change in irradiation time.
    - e. Any time the laboratory is left unattended, even for short periods of time.
    - f. Any change of pneumatic tube operators.
    - g. When the experiment is concluded.
  - H. Any point during the Serial Mode of operation, the experimenter must be able to expeditiously determine the number of irradiations completed.
  - I. At the end of the experiment, or at any break point when the laboratory is to be left unattended for any period, the experimenter will terminate the Serial Model (see exception below) by the following steps:
    - a. Contact the control room and inform the operator that the Serial Mode is being terminated.
    - b. Inform the operator of the total number of irradiations completed.
    - c. Secure the pneumatic tube control station.
    - d. Complete the pneumatic tube log.

VIII.3.4.1 Cont'd

**EXCEPTION:** With agreement from the control room, the experimenter can take short (~ 5 minutes) breaks without terminating the run. In such cases the experimenter will contact the control room and request a break. The experimenter will lock the lab door. In no case shall the experimenter leave the building during these short breaks. These breaks cannot be requested while there is a rabbit in the reactor. When the experimenter resumes the run, he/she shall again contact the control room and report that the run is being resumed.

VIII.3.4.2 After blowers are verified "ON" by the control room operator, the system will be operated as described in steps A through F of this section. When the Serial Mode of operation is to be used, the control room operator will stay in audio contact for one cycle.

(THE POSITION OF ALL CONTROLS AND INDICATIONS ARE SHOWN ON FIGURE VIII-1)

NOTE: The "RETURN" pushbutton will return rabbit to fume hood during any portion of irradiation cycle.

- A. Set timer to desired irradiation time.
  - 1. Depress and hold pushbutton I.
  - 2. Depress numbered pushbutton until desired time is indicated on display (HH.MM.SS).
  - 3. Release pushbutton I.
  - 4. Timer is now set, and need not be touched again until a new irradiation time is required.
- B. Place power switch to "ON" ("System in use" lamp lights).
- C. Depress "Dispatch" pushbutton (system is now lined-up to accept rabbit).
- D. Insert rabbit, with cap down.
- E. Observe that "Rabbit in Reactor" lamp lights, and that the timer starts. Then state to the control room operator that "The rabbit is in the reactor."

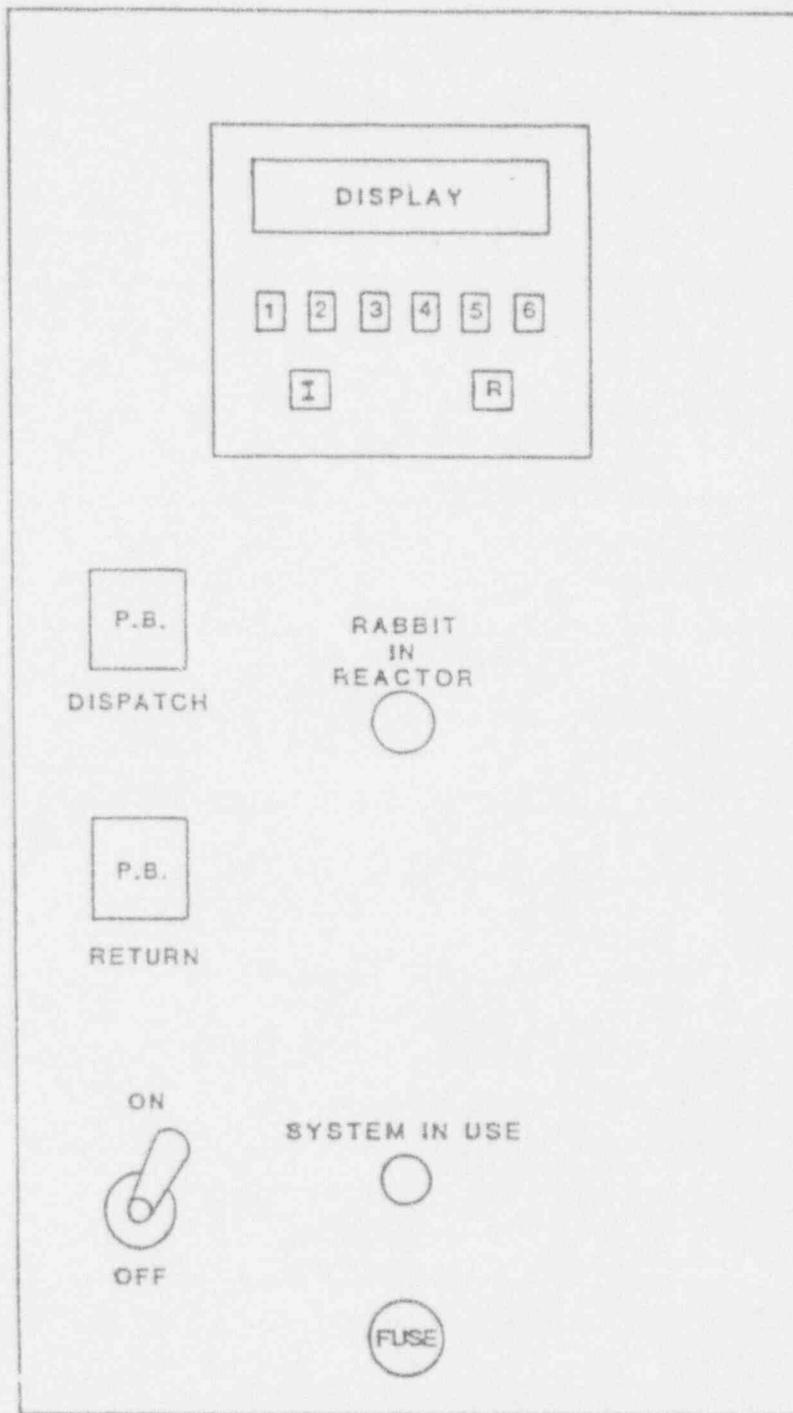


Figure VIII-1  
 Control Station for Laboratories  
 216, 218, 227, 228

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SOP/VIII-15 ]  
 Reset

### VIII.3.4.2 Cont'd

- F. At the end of the pre-selected irradiation time, the rabbit will be returned to the "catcher" in the fume hood. The experimenter should state to the control room operator that "The rabbit is back." In the case of serial operations, a communication should be exchanged between the experimenter and operator that such is the case for the first rabbit run.
- G. If more than one rabbit is to be run, using same irradiation time, depress "Dispatch" pushbutton and insert next rabbit.
- H. After last rabbit is run, place power switch to "OFF."
- I. Call control room and give the irradiation time for the rabbit and number of rabbits irradiated. Verify numbers consistent with those reported in Section VIII.3.4.1.E and F. If different, determine cause of discrepancy. In the case of serial operations, review steps F through I of VIII.3.4.1 above.

VIII.3.4.3 After the rabbit has returned from the reactor, check the dose rate.

### VIII.3.5. P-Tube Emergency Procedures

VIII.3.5.1 The most common occurrences will be trouble with the station controls, the possibility of the rabbit sticking in the tube, and the rabbit coming apart in the pneumatic tube system.

### VIII.3.5.2 Station Control Malfunction

- A. If a boron shielded rabbit is in the reactor and is not automatically returned at the maximum irradiation time, immediately notify the control room. The control room operator will initiate a manual RRI to about 500 kw. Press the "return" pushbutton. Control room operators can then listen for rabbit movement.
- B. If a standard rabbit is in the reactor and is not automatically discharged, immediately notify the control room and then press the "return" pushbutton. The control room operator can then listen for rabbit movement.
- C. If the rabbit is not in the reactor and station controls do not work, call the control room. The reactor operator will then get in touch with the electronic technician.

NOTE: The experimenter is NOT authorized to attempt repair of the system.

### VIII.3.5.2 Station Control Malfunction (cont'd)

1

- C. Report to the control room the material contained in the sample, the expected activity and dose rate, and the approximate time the rabbit can remain in the reactor without creating any hazard.
- D. The reactor operator will get in touch with a health physics technician to monitor as required.

### VIII.3.5.3 Rabbit Stuck in Tube

Any time all or any part of a rabbit fails to return to the dispatch station, notify the control room immediately about the problem, stating the material contained in the sample, the weight of the sample, the expected activity and dose rate, and the approximate time the rabbit can remain in the reactor without creating any hazard or melting.

- A. After the control room is aware of the problem, press the "return" pushbutton. Observe the rabbit in reactor light and check with the control room to see if the operators heard the rabbit leave the reflector region. Hearing the rabbit depart the reflector is the only sure way to know it has left. If the rabbit was heard to depart the reflector region, check the other connecting station to see if the rabbit was returned there.
- B. Depress the dispatch button.
- C. Repeat steps A and B several times as directed by the control room.
- D. If the attempts fail, turn control box off. Go to the other connecting station, line it up for service and repeat steps A and B.
- E. If rabbit still has not returned, a chaser rabbit may be inserted in an attempt to dislodge the stuck rabbit. Before the chaser rabbit is dispatched it will be marked so that it can be readily identified, thus preventing confusion with the stuck rabbit should it return. CHASER RABBIT ID MARK SHOULD GO ACROSS ONE END CAP, ALONG THE SIDE AND ACROSS THE OTHER END CAP.
- F. If these procedures have failed, follow up action will be handled by reactor operations and health physics personnel.

NOTE: If the rabbit is stuck outside the reactor it may be found by searching the guide tubes with a radiation monitor. If the rabbit is stuck in the reflector, the reactor may have to be shutdown and the p-tube removed.

### VIII.3.5.4 Wet Rabbit

If the outside of the rabbit is wet when it is returned from the reactor, notify the control room immediately.

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VIII.3.6 Emergency Return of Rabbit with Malfunctioning  
P-Tube Control Box

Dispatch and return of the rabbit is controlled by solenoids in cabinet located by the seal trench. All solenoids in use are labeled by letters in the solenoid cabinet. Procedure to be followed in case of a failure at the local station is as follows:

- A. Remove cover to solenoid cabinet.
- B. Turn solenoid power switch off (this de-energizes all solenoids).

NOTE: THIS CLOSES OFF ALL TUBES WHICH WILL RESULT IN A HIGH CONCENTRATION OF AR<sup>4+</sup> IF THE REACTOR IS OPERATING.

|                    |                    |
|--------------------|--------------------|
| Room 216 - R and J | Dispatch solenoids |
| Room 218 - Q and J | Dispatch solenoids |
| Room 227 - B and N | Dispatch solenoids |
| Room 228 - A and N | Dispatch solenoids |

Refer to solenoid schedule.

- C. Energize the P-tube blowers.
- D. Then, "manually" depress following solenoids in solenoid cabinet.

|                    |                  |
|--------------------|------------------|
| Room 216 - U and L | Return solenoids |
| Room 218 - V and L | Return solenoids |
| Room 227 - G and O | Return solenoids |
| Room 228 - H and O | Return solenoids |

As an example, the solenoids for return to room 216 should be in the following positions: solenoids R and J "up"; solenoids U and L "down".

VIII.8 RESPONSE PROCEDURES FOR THE ALPHA LABORATORY

When responding to alarms from the Alpha Laboratory and the Argon Glove Box, an initial attempt to contact the laboratory to notify any lab personnel present shall be made. If no answer, or if otherwise determined necessary, proceed with the following procedure. ]

NOTE: Maintaining an inert argon atmosphere is the principal fire safety feature of the argon glove box. The following alarms may not have immediate safety implications, however, they indicate a degradation in the fire safety feature of the argon glove box and indicate a potential loss of glove box integrity.

VIII.8.1 RESPONSE TO ALPHA LABORATORY HIGH AIRBORNE RADIOACTIVITY ALARM (Exhaust and/or Room Monitor)

1. Notify shift supervisor and Health Physics Manager.
2. Monitor readings on facility exhaust particulate monitor in control room. An assessment of the off-site radiological consequences shall be made. ]
3. If the stack particulate monitor indicates a steady increase coinciding with an alpha-6 alarm, **secure** the reactor, and **turn off** EF-13 and EF-14 at the breakers on the Emergency Distribution Center. ]
4. Ensure persons have evacuated the Alpha Laboratory. If no experimenter is present, call the on-call experimenter as soon as time permits.

WARNING: DO NOT enter room, except for life saving or accident mitigation efforts, until Health Physics arrives. **If emergency entry is made, wear emergency breathing apparatus.** ]

5. Secure the Alpha Laboratory exhaust and supply fans locally.
6. Shut the Alpha Laboratory supply damper only.
7. With Health Physics coverage, enter Alpha Laboratory using **emergency breathing apparatus** to locate and repair source of airborne activity. ]

SUBSEQUENT ACTION: Assist recovery and decontamination procedures for the Alpha Laboratory and basement in vicinity of Alpha Laboratory.

## VIII.8.2 HIGH OXYGEN IN GLOVE BOX ALARM

NOTE: The continuously operated oxygen monitor (located in the DRI-TRAIN rack) is the most sensitive indication of air leakage into the argon glove box.

1. Verify no increased airborne activity on the stack monitor.
2. **Notify Shift Supervisor and Health Physics technician.** ]
3. Contact TRUMP-S scientist on call. ]
4. a) **Check the warning light panel outside the door and check the argon glove box pressure indicated on the three photohelic gauges located on top of the argon glove box. (Normal range -0.1 to -2.0 inches of water).** ]  
] ] ] ]  
b) If pressure is near zero, then the possibility of a leak exists and the glove box should be visually inspected from the window to the Alpha Laboratory.
5. Check the Alpha Laboratory exhaust monitor (**alpha-6**) and the Alpha Laboratory room monitor (**alpha-3**) for indication of elevated activity. ] ]  
a) If no elevated activity is indicated on either monitor, enter the laboratory by normal entry procedure, TAM-10.  
b) If elevated activity is indicated, see SOP VIII.8.1, Response to Alpha Laboratory High Airborne.
6. Check NITRAIN/DRI-TRAIN units for loss of power. ]
7. Check glove ports covered. ]
8. Check oxygen monitor reading. If reading exceeds 100 ppm, secure the argon box well heater (**use range switch if indication is off-scale**). ] ] ]
9. Investigate source of leakage and temporarily seal, if possible. ]
10. Exit Alpha Laboratory by normal exit procedures, TAM-10. ]
11. Assist TRUMP-S scientist and Health Physics in determining source and corrective action. ]

### VIII.8.3 LOW ARGON SYSTEM PRESSURE ALARM

NOTE: This alarm may indicate an argon system leak or a loss of integrity of the argon glove box **or simply low argon bottle pressure.** ]  
(A loss of glove box integrity **will** also cause High Oxygen Alarm.) ]  
The pressurized argon gas bottles provide argon makeup to the argon conditioning system (a recirculating purification system) associated with the argon glove box.

1. Check the argon bank pressure at inner passageway. Replace bottles, if necessary. ]
2. **Notify Shift Supervisor and** Health Physics technician. ]
3. Call the TRUMP-S scientist on call. ]
4. Inspect argon gas bottle system and argon line to Alpha Laboratory for leaks. Repair any leaks, if possible.
5. a) Check the argon glove box pressure indicated on the photohelic gauge located on top of the argon glove box. (**Normal range -0.1 to -2.0 inches of water.**) ]  
b) If pressure is near zero, then the possibility of a leak exists and the glove box should be visually inspected from the Alpha Laboratory window.
6. Check the Alpha Laboratory exhaust monitor and the Alpha Laboratory room monitor for indication of elevated activity. ]  
a) If no elevated activity is indicated on either monitor, enter the laboratory by normal entering procedure, TAM-10.  
b) If activity is indicated, see SOP VIII.3.1, Response to Alpha Laboratory High Airborne Activity.
7. Check NITRAIN/DRI-TRAIN units for loss of electrical power (pressure control system is part of DRI-TRAIN unit). ]
8. Inspect argon purification system and argon glove box for leaks. ]
9. If argon pressure cannot be restored in 60 minutes or if oxygen monitor alarms and indicates greater than 100 ppm, secure the argon box well heater. ]
10. Exit Alpha Laboratory by normal exit procedure, TAM-10. ]
11. Assist TRUMP-S scientist and Health Physics in determining corrective actions. ]

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SOP/VIII-46 |

REP-12

LOSS OF DOMESTIC COLD WATER TO FACILITY

IMMEDIATE ACTIONS:

1. Send operator to monitor secondary sump level.
2. Secure the main air compressor.

SUBSEQUENT ACTIONS:

1. Notify the Shift Supervisor.
2. Announce to the entire facility that domestic cold water service has been interrupted. ]
3. IF service water cannot be restored within a reasonable amount of time, SHUTDOWN the reactor and secure primary coolant pumps. ]
4. Secure and tag out the following equipment: ]
  - a. Secondary pumps P1, P2, P3, and P4, after the reactor has been shutdown (P4 can be left on for building A/C support at the discretion of the Shift Supervisor).
  - b. Vacuum unit pumps.
  - c. Alpha Lab. thermal well (notify Alpha Lab. staff).
  - d. Air conditioning units. (If all secondary pumps are secured.)
  - e. Hot water recirculating pump.
  - f. Room 212 (north counting room) air conditioner. (Notify Nuclear Analysis Program)
  - g. Room 232B (west counting room) air conditioner. (Notify Nuclear Analysis Program.)
  - h. Room 260 air conditioning unit.
  - i. Ice machine.
  - j. Control Room water heater.
  - k. RTAH recirculating pump (tag at motor controller at DI-200 regeneration station).
5. Make console entry that the machinery above has been tagged out as per REP-12, and fill out UNSCHEDULED SHUTDOWN REPORT. ]

RECOVERY ACTIONS:

1. Upon restoration of water to the facility, return all systems to normal status.
2. Announce to entire facility the restoration of domestic cold water service.

REP-22  
BOMB OR OTHER OVERT THREATS

Upon any direct threat or actions by any person or group of persons which may endanger personnel safety or the safe operation of the reactor, the reactor operator shall:

IMMEDIATE ACTIONS:

1. SHUTDOWN the reactor immediately.
2. Secure the master control switch.
3. Notify the UNIVERSITY POLICE by telephone.
4. Ensure all doors are secure, with priority to the truck entry door and personnel airlock door. ]
5. Facility evacuation or partial evacuation may be used to remove persons from affected areas.

SUBSEQUENT ACTIONS:

1. Notify the Shift Supervisor.
2. Make console entry and fill out UNSCHEDULED SHUTDOWN REPORT.

NOTE: Facility staff should not enter any direct conflict except when necessary for their own personal safety.



| DATE _____            | MODE _____ | PROCESS DATA |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------|------------|--------------|--|--|--|--|--|--|--|--|--|--|--|
| Time                  |            |              |  |  |  |  |  |  |  |  |  |  |  |
| In Pool Ht. Exch.     |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pressurizer Level     |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pool Refl. $\Delta P$ |            |              |  |  |  |  |  |  |  |  |  |  |  |
| PS 944A               |            |              |  |  |  |  |  |  |  |  |  |  |  |
| PS 944B               |            |              |  |  |  |  |  |  |  |  |  |  |  |
| DPS 928A              |            |              |  |  |  |  |  |  |  |  |  |  |  |
| DPS 928B              |            |              |  |  |  |  |  |  |  |  |  |  |  |
| DPS 929               |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. $T_h$ (1)        |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. $T_c$ (2)        |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. $\Delta T$       |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. Water Flow       |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pool $T_c$ Loop A (3) |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pool $T_c$ Loop B (4) |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. $T_h$ Pool A (5) |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Sec. $T_h$ Pri. A (6) |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Rx Cond In            |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Rx Cond Out           |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pool Cond In          |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Pool Cond Out         |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Stack Gas             |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Stack Part.           |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Stack Iodine          |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Operator              |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Reader                |            |              |  |  |  |  |  |  |  |  |  |  |  |
|                       |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Heat Balance By       |            |              |  |  |  |  |  |  |  |  |  |  |  |
| Manual Calculation:   |            |              |  |  |  |  |  |  |  |  |  |  |  |

# REACTOR ROUTINE PATROL

DATE: \_\_\_\_\_

|                                      |  |  |  |  |  |  |  |
|--------------------------------------|--|--|--|--|--|--|--|
| 1. Time of start of patrol           |  |  |  |  |  |  |  |
| 2. Time and date all charts          |  |  |  |  |  |  |  |
| 3. Visual check of entire pool       |  |  |  |  |  |  |  |
| 4. Anti-siphon tank pressure         | 36 psig $\pm$ 3 psi                          |  |  |  |  |  |  |
| 5. North iso door seal pressure      | 18-28 psig                                   |  |  |  |  |  |  |
| 6. South iso door seal pressure      | 18-28 psig                                   |  |  |  |  |  |  |
| 7. 5th level backup doors            | open   |  |  |  |  |  |  |
| 8. 16" iso vlv A air pressure        | 45-55 psig                                   |  |  |  |  |  |  |
| 9. 16" iso vlv B air pressure        | >80 psig                                     |  |  |  |  |  |  |
| 10. Emerg air compress on standby    | Bkr closed, vlv open,<br>gage $\geq$ 80 psig |  |  |  |  |  |  |
| 11. Containment hot sump pumps       | Operable                                     |  |  |  |  |  |  |
| 12. Door 101 seal pressure           | 18-28 psig                                   |  |  |  |  |  |  |
| 13. BP floor                         | Conditions normal                            |  |  |  |  |  |  |
| 14. Fuel vault                       | Locked                                       |  |  |  |  |  |  |
| 15. Inner airlock door seal pressure | 18-28 psig                                   |  |  |  |  |  |  |
| 16. Outer airlock door seal pressure | 18-28 psig                                   |  |  |  |  |  |  |
| 17. Cold deck temperature            | 45-65 deg F                                  |  |  |  |  |  |  |
| 18. Argon bank pressure              | >200 psig                                    |  |  |  |  |  |  |
| 19. Full N2 bottles                  | Total > 3                                    |  |  |  |  |  |  |
| 21. Bank on service                  | A or B                                       |  |  |  |  |  |  |
| 23. Bank A bottle pressure           | > 250 psig                                   |  |  |  |  |  |  |
| 24. Bank B bottle pressure           | > 250 psig                                   |  |  |  |  |  |  |
| 25. N2 header pressure               | 135-145 psi                                  |  |  |  |  |  |  |
| 26. T-300 level                      | >2000 gal                                    |  |  |  |  |  |  |

On the first routine patrol of the day or the first patrol after a startup, drain all water from the anti-siphon system. If draining causes the pressure to drop significantly, return to the middle of the band (36 psig) and record the pressure here. If a condition or reading is normal, enter a "√" (for conditions) or the reading in the applicable box. If the condition is abnormal, enter the condition or reading and circle it. Explain all abnormal conditions or readings in the REMARKS on page 3.

# REACTOR ROUTINE PATROL

DATE: \_\_\_\_\_

|  |   |  |  |  |  |  |  |
|--|---|--|--|--|--|--|--|
| 27. T-301 level  | <6000 gal   |  |  |  |  |  |  |
| 28. Labyrinth sump   | Level < Alarm Pt.   |  |  |  |  |  |  |
| 29. RO unit  | Condition normal  |  |  |  |  |  |  |
| 30. UPS room   | NO Alarms Indicated<br>Temp 60 <sup>o</sup> - 80 <sup>o</sup> F |  |  |  |  |  |  |
| 31. T- 300, T-301 Room   | Thermostat >55 <sup>o</sup> F<br>Temp. >40 <sup>o</sup> F       |  |  |  |  |  |  |
| 32. Rm 114 particulate filter ΔP   | <3.5" water   |  |  |  |  |  |  |
| 33a. EG. Rm. (Perform complete checklist on Sunday)                            | Thermostat >60 <sup>o</sup> F<br>Temp. >50 <sup>o</sup> F       |  |  |  |  |  |  |
| 33b. Battery charging current  | <1 amp  |  |  |  |  |  |  |
| 33c. Battery Voltage   | > 28 V  |  |  |  |  |  |  |
| 34. External doors   | All locked except east when sec. on duty                        |  |  |  |  |  |  |
| 35. CT basin water level   | 5 - 10"   |  |  |  |  |  |  |
| 36. Automatic secondary makeup vlv   | Auto or open  |  |  |  |  |  |  |
| 37. Acid day tank level (Perform weekly level check on Friday on storage tank) | Visible   |  |  |  |  |  |  |
| 38. Acid control and pH  | Range as posted   |  |  |  |  |  |  |
| 39. Blowdown control/cond.   | Range as posted   |  |  |  |  |  |  |
| 40. CT sump pumps  | Operable  |  |  |  |  |  |  |
| 41. P-pump(s) running  |   |  |  |  |  |  |  |
| 42. Pump strainer ΔP   | 0 - 7.0 psi   |  |  |  |  |  |  |
| 43. Discharge pressure   |   |  |  |  |  |  |  |
| 44. Pump strainer ΔP   | 0 - 7.0 psi   |  |  |  |  |  |  |
| 45. Discharge pressure   |   |  |  |  |  |  |  |
| 46. Tunnel sump pumps  | Operable  |  |  |  |  |  |  |
| 47. WT booster fan   | Running   |  |  |  |  |  |  |
| 48. Fission product monitor flow   | 95 - 105 cc/min   |  |  |  |  |  |  |
| 49. Vlv control header pressure  | 90 - 125 psig   |  |  |  |  |  |  |
| 50. Pressurizer N2 supply press  | 90 - 100 psig   |  |  |  |  |  |  |
| 51. Check rm 114 from door   |   |  |  |  |  |  |  |
| 52. Deltech oil filters "red level" and blow down                              | < 75% dark red  |  |  |  |  |  |  |



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Rev. 5/02/89 App'd Wam

SOP/A-18b ]  
Reset

SECONDARY SYSTEM NORMAL OPERATION  
VALVE LINE-UP CHECKSHEET

This checksheet shall be completed when required by the SOP. The operator performing the check will verify the position of each valve and indicate the verification by initialing the checksheet. Under the direction of the Shift Supervisor, a valve may be positioned other than noted on this sheet. The operator will check the valve to be in the desired position and write in the actual position of the valve. The reason for the valve being positioned abnormally will be noted in the COMMENTS section.

Throttled valves shall be checked to be in the position shown by the tag on the valve. Note the valve's position in the space provided on the checksheet.

The following valves will be found in the cooling tower or cooling tower tunnel.

|       | Valve #   | Valve Description                           | Position |
|-------|-----------|---|----------|
| _____ | 1. S-5    | P-1 discharge                               | Open     |
| _____ | 2. S-6    | P-2 discharge                               | Open     |
| _____ | 3. S-7    | P-3 discharge                               | Open     |
| _____ | 4. S-8    | P-1 suction                                 | Open     |
| _____ | 5. S-9    | P-2 suction                                 | Open     |
| _____ | 6. S-10   | P-3 suction                                 | Open     |
| _____ | 7. S-11   | P-4 suction                                 | Open     |
| _____ | 8. S-12   | P-4 discharge                               | Open     |
| _____ | 9. S-105  | P-4 strainer DP gauge                       | Open     |
| _____ | 10. S-106 | P-4 strainer DP gauge                       | Open     |
| _____ | 11. S-107 | P-1 strainer DP gauge                       | Open     |
| _____ | 12. S-108 | P-1 strainer DP gauge                       | Open     |
| _____ | 13. S-109 | P-2 strainer DP gauge                       | Open     |
| _____ | 14. S-110 | P-2 strainer DP gauge                       | Open     |
| _____ | 15. S-111 | P-3 strainer DP gauge                       | Open     |
| _____ | 16. S-112 | P-3 strainer DP gauge                       | Open     |
| _____ | 17. S-114 | P-1 suction pressure gauge                  | Open     |
| _____ | 18. S-115 | P-2 suction pressure gauge                  | Open     |
| _____ | 19. S-116 | P-3 suction pressure gauge                  | Open     |
| _____ | 20. S-117 | P-4 discharge pressure gauge                | Open     |
| _____ | 21. S-118 | P-1 discharge pressure gauge                | Open     |
| _____ | 22. S-119 | P-2 discharge pressure gauge                | Open     |
| _____ | 23. S-120 | P-3 discharge pressure gauge                | Open     |
| _____ | 24. S-128 | Chemical addition connection (ground level) | Open     |
| _____ | 25. S-155 | Chemical addition connection (ground level) | Open     |

|       | Valve #   | Valve Description                             | Position |
|-------|-----------|---|----------|
| _____ | 26. S-163 | Drain of relief valve on pump discharge       | Open     |
| _____ | 27. S-197 | Conductivity and pH sampling (ground level)   | Open     |
| _____ | 28. S-198 | Conductivity and pH sampling (ground level)   | Open     |
| _____ | 29. S-17  | Cooling tower distribution valve              | Open     |
| _____ | 30. S-18  | Cooling tower distribution valve              | Open     |
| _____ | 31. S-19  | Cooling tower distribution valve              | Open     |
| _____ | 32. S-20  | Cooling tower distribution valve              | Open     |
| _____ | 33. S-21  | Cooling tower distribution valve              | Open     |
| _____ | 34. S-22  | Cooling tower distribution valve              | Open     |
| _____ | 35. S-47B | P-4 return to cooling tower distribution line | Open     |
| _____ | 36. S-113 | Drain isolation (2") on secondary supply      | Closed   |
| _____ | 37. S-121 | P-4 line vent                                 | Closed   |
| _____ | 38. S-123 | P-1, 2 & 3 line vent                          | Closed   |
| _____ | 39. S-125 | To floor drain                                | Closed   |
| _____ | 40. S-101 | Return line to floor drain                    | Closed   |
| _____ | 41. S-126 | Return line to floor drain                    | Closed   |
| _____ | 42. S-102 | Condensers to floor drain                     | Closed   |
| _____ | 43. S-129 | Drains return line to cooling tower basin     | Closed   |
| _____ | 44. S-127 | P-4 discharge to cooling tower (ground level) | Closed   |
| _____ | 45. S-47A | P-4 to cell #1 south (winter & maintenance)   | Closed   |
| _____ | 46. S-196 | Drain valve for P-4 cell #1 south             | Closed   |

The following valves will be found in the 114 passageway:

|       |           |  |           |
|-------|-----------|--|-----------|
| _____ | 47. S-170 | From building air supply                 | Open      |
| _____ | 48. S-171 | Air supply to primary heat exchangers    | Open      |
| _____ | 49. S-172 | Air supply to pool heat exchangers       | Open      |
| _____ | 50. S-202 | Corrosion rack isolation - in            | Open      |
| _____ | 51. S-203 | Corrosion rack isolation - out           | Open      |
| _____ | 52. 170   | Blowdown isolation                       | Throttled |
| _____ | 53. S-103 | Supply to conductivity and pH detectors  | Closed    |
| _____ | 54. S-151 | Return from conductivity and pH detector | Closed    |
| _____ | 55. S-199 | Blowdown isolation (ball valve)          | Closed    |
| _____ | 56. S-164 | Return drain to floor                    | Closed    |
| _____ | 57. S-165 | Supply drain to floor                    | Closed    |
| _____ | 58. DCWR7 | DCW from Alpha Lab                       | Closed    |

The following valves will be found in Room 114:

|       | Valve #   | Valve Description            | Position |
|-------|-----------|------------------------------|----------|
| _____ | 59. S-161 | dp transmitter hp isolation  | Open     |
| _____ | 60. S-183 | Rosemount hp isolation       | Open     |
| _____ | 61. S-130 | Bailey hp isolation          | Open     |
| _____ | 62. S-182 | Rosemount lp isolation       | Open     |
| _____ | 63. S-131 | Bailey lp isolation          | Open     |
| _____ | 64. S-162 | dp transmitter lp isolation  | Open     |
| _____ | 65. S-23  | HX503A supply isolation      | Open     |
| _____ | 66. S-24  | HX503B supply isolation      | Open     |
| _____ | 67. S-25  | HX521B supply isolation      | Open     |
| _____ | 68. S-26  | HX521A supply isolation      | Open     |
| _____ | 69. S-30  | S-1 supply side isolation    | Open     |
| _____ | 70. S-31  | S-1 return side isolation    | Open     |
| _____ | 71. S-34  | S-2 supply side isolation    | Open     |
| _____ | 72. S-35  | S-2 return side isolation    | Open     |
| _____ | 73. S-39  | HX503A return side isolation | Open     |
| _____ | 74. S-41  | HX503B return side isolation | Open     |
| _____ | 75. S-43  | HX521A return side isolation | Open     |
| _____ | 76. S-45  | HX521B return side isolation | Open     |
| _____ | 77. S-173 | HX521A sparge                | Open     |
| _____ | 78. S-145 | HX521A line vent             | Open     |
| _____ | 79. S-174 | HX521B sparge                | Open     |
| _____ | 80. S-176 | HX503A sparge                | Open     |
| _____ | 81. S-178 | HX503B sparge                | Open     |
| _____ | 82. S-154 | Vent return header (HX521B)  | Closed   |
| _____ | 83. S-181 | Bailey hp test connection    | Closed   |
| _____ | 84. S-185 | Rosemount hp test connection | Closed   |
| _____ | 85. S-184 | Equalizing valve             | Closed   |
| _____ | 86. S-186 | Rosemount lp test connection | Closed   |
| _____ | 87. S-180 | Bailey lp test connection    | Closed   |
| _____ | 88. S-133 | Transmitter flush valve      | Closed   |
| _____ | 89. S-27  | S-1 bypass valve             | Closed   |
| _____ | 90. S-28  | S-2 bypass valve             | Closed   |
| _____ | 91. S-29  | Heat exchanger bypass valve  | Closed   |
| _____ | 92. S-157 | HX521A flush                 | Closed   |
| _____ | 93. S-158 | HX521A flush                 | Closed   |
| _____ | 94. S-139 | HX521A drain                 | Closed   |

|       | Valve #    | Valve Description                       | Position |
|-------|------------|---|----------|
| _____ | 95. S-138  | HX521A drain                            | Closed   |
| _____ | 96. S-143  | HX521A vent                             | Closed   |
| _____ | 97. S-140  | HX521B drain                            | Closed   |
| _____ | 98. S-175  | HX521B flush connection                 | Closed   |
| _____ | 99. S-144  | HX521B vent                             | Closed   |
| _____ | 100. S-137 | HX503B drain                            | Closed   |
| _____ | 101. S-142 | HX503B vent                             | Closed   |
| _____ | 102. S-136 | S-1 drain                               | Closed   |
| _____ | 103. S-134 | Hydro connection                        | Closed   |
| _____ | 104. S-135 | Hydro connection                        | Closed   |
| _____ | 105. S-141 | HX503A vent                             | Closed   |
| _____ | 106. S-117 | HX503A drain                            | Closed   |
| _____ | 107. S-145 | Vent HX521A                             | Closed   |
| _____ | 108. S-195 | Return to HX503A from waste heat system | Closed   |
| _____ | 109. S-194 | Supply from HX503B to waste heat system | Closed   |

The following valve is found in the waste tank room:

|       |            |                      |        |
|-------|------------|----------------------|--------|
| _____ | 110. S-169 | Waste tank isolation | Closed |
|-------|------------|----------------------|--------|

For operation of the air conditioners with feed water from P-1, P-2, P-3, or P-4.

The following valves will be found in Room 278:

|       |            |                                     |        |
|-------|------------|-------------------------------------|--------|
| _____ | 111. S-53  | Supply to A/C unit #2               | Open   |
| _____ | 112. S-57  | Discharge A/C unit #2               | Open   |
| _____ | 113. S-55  | Supply to A/C unit #1 (LiBr)        | Open   |
| _____ | 114. S-58  | Discharge A/C unit #1 (LiBr)        | Open   |
| _____ | 115. S-200 | Flow isolation                      | Open   |
| _____ | 116. S-201 | Flow isolation                      | Open   |
| _____ | 117. S-146 | Vent (by DI-300)                    | Closed |
| _____ | 118. S-54  | Vent (by steam supply to LiBr unit) | Closed |
| _____ | 119. S-149 | Vent (by DI-300)                    | Closed |

For operation of the auxiliary heating and cooling system.

|       | <u>Valve #</u> | <u>Valve Description</u>                     | <u>Position</u> |
|-------|----------------|--|-----------------|
| _____ | 120. AX-2      | Auxiliary heat pump suction                  | Open            |
| _____ | 121. AX-3      | Auxiliary heat pump discharge                | Open            |
| _____ | 122. AX-4      | Auto control valve for auxiliary heat system | Open            |
| _____ | 123. AX-8      | Supply side isolation                        | Open            |
| _____ | 124. AX-9      | Return side isolation                        | Open            |

The following valves are open in winter and closed in summer:

|       |           |                            |
|-------|-----------|----------------------------|
| _____ | 125. AX-1 | Secondary supply isolation |
| _____ | 126. AX-5 | Secondary return isolation |

The following valves are open in summer and closed in winter:

|       |           |                              |
|-------|-----------|------------------------------|
| _____ | 127. AX-6 | Chill water supply isolation |
| _____ | 128. AX-7 | Chill water return isolation |

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## DI SYSTEM VALVE LINE-UP CHECKSHEET

NOTE: Check the DI resin log and status board for the current status of all DI beds and filter banks.

| Valve | Valve Description                | Position |
|-------|----------------------------------|----------|
| 515Q  | DI return to pool                | Closed   |
| 515M  | DI suction from pool             | Closed   |
| 515T  | DI suction from loop             | Open     |
| 515P  | DI return to pool                | Open     |
| 515AC | Pool DI to blank flange          | Closed   |
| 515J  | P-513 suction                    | Open     |
| 515L  | P-513 discharge                  | Open     |
| DI-10 | Air to DI-200                    | Closed   |
| DI-11 | Air to DI-201                    | Closed   |
| DI-12 | Air to DI-202                    | Closed   |
| DI-13 | Drain to floor                   | Closed   |
| DI-14 | Drain to DCT                     | Closed   |
| RE-1  | Water isolation to vent tank     | Closed   |
| RE-2  | R-200 water isolation            | Closed   |
| RE-3  | R-200 water isolation            | Closed   |
| RE-4  | R-200 water isolation            | Closed   |
| RE-5  | *                                | Closed   |
| RE-6  | *                                | Closed   |
| RE-7  | R-200 isolation to drain         | Closed   |
| RE-8  | R-200 isolation to drain         | Closed   |
| RE-9  | R-200 vent                       | Closed   |
| RE-10 | R-200 air isolation              | Closed   |
| RE-11 | Resin dump                       | Closed   |
| RE-12 | Resin suction                    | Closed   |
| RE-13 | Eductor isolation                | Closed   |
| RE-14 | R-200 to vent tank               | Closed   |
| RE-15 | to floor drain                   | Closed   |
| RE-16 | to Water Tank #2                 | Closed   |
| RE-17 | 10 gpm flow meter throttle valve | Closed   |
| RE-18 | 50 gpm flow meter throttle valve | Closed   |
| RE-19 | 10 gpm flow meter throttle valve | Closed   |
| RE-20 | Vent tank vent                   | Closed   |
| RE-21 | Water isolation to sample sink   | Closed   |

\*These valves used only when regenerating DI beds per SMP-16.

| Valve | Valve Description              | Position |
|-------|--------------------------------|----------|
| RE-22 | *                              | Closed   |
| RE-23 | Sample line isolation          | Closed   |
| RE-24 | R-200 to floor drain           | Closed   |
| RE-25 | Air system isolation           | Closed   |
| RE-26 | DI from DI-300 isolation       | Closed   |
| RE-27 | DCW isolation                  | Closed   |
| RE-28 | DHW isolation                  | Closed   |
| RE-30 | DI to regeneration from DI-300 | Closed   |
| RE-31 | DI to T-300                    | Closed   |
| RE-33 | *                              | Closed   |
| RE-34 | Air isolation to regeneration  | Closed   |
| RE-47 | Vent tank drain                | Closed   |
| RE-52 | HP air system bleed valve      | Closed   |
| RE-53 | HP air pressure regulator      | Closed   |
| RE-55 | *                              | Closed   |
| RE-56 | *                              | Closed   |
| RE-57 | *                              | Closed   |
| RE-58 | *                              | Closed   |
| RE-59 | *                              | Closed   |
| RE-60 | *                              | Closed   |
| RE-61 | *                              | Closed   |
| RE-62 | *                              | Closed   |
| RE-63 | *                              | Closed   |
| RE-64 | *                              | Closed   |
| RE-65 | *                              | Closed   |
| RE-66 | *                              | Closed   |
| RE-67 | *                              | Closed   |
| RE-68 | Hose drain                     | Closed   |
| RE-70 | Drain to Waste Tank #2         | Closed   |
| RE-89 | DI from T-300 isolation        | Closed   |
| RE-90 | *                              | Closed   |
| RE-91 | *                              | Closed   |

\*These valves used only when regenerating DI beds per SMP-16.

| <u>Valve</u>                                  | <u>Valve Description</u>      | <u>Position</u> |
|---|-------------------------------|-----------------|
| <b><u>RESIN STORAGE TANK</u></b>              |                               |                 |
| RS-1  | Vent                          | Closed          |
| RS-2  | Sluice to DI units (top)      | Closed          |
| RS-3  | Sluice from DI units (top)    | Closed          |
| RS-4  | Air supply                    | Closed          |
| RS-5  | Drain                         | Closed          |
| RS-6  | Sluice to DI units (bottom)   | Closed          |
| RS-7  | Sluice from DI units (bottom) | Closed          |
| <b><u>R-200</u></b>                           |                               |                 |
| R-1   | Sluice from DI units          | Closed          |
| R-2   | Water to sluice DI units      | Closed          |
| R-3   | Sluice to DI units            | Closed          |
| R-5   | Eductor isolation             | Closed          |
| <b><u>POOL INLET FILTER BANK F-200</u></b>    |                               |                 |
| F-1   | Inlet                         | Open            |
| F-2   | Bypass                        | Closed          |
| F-3   | Outlet                        | Open            |
| <b><u>PRIMARY INLET FILTER BANK F-201</u></b> |                               |                 |
| F-4   | Inlet                         | Open            |
| F-5   | Bypass                        | Closed          |
| F-6   | Outlet                        | Open            |
| <b><u>PRIMARY OUTLET FILTER BANKS</u></b>     |                               |                 |
| <b><u>F-202 off service (on service)</u></b>  |                               |                 |
| F-7   | Inlet                         | Closed (Open)   |
| F-8   | Outlet                        | Closed (Open)   |
| <b><u>F-203 off service (on service)</u></b>  |                               |                 |
| F-9   | Inlet                         | Closed (Open)   |
| F-10  | Outlet                        | Closed (Open)   |
| <b><u>POOL OUTLET FILTER BANKS</u></b>        |                               |                 |
| <b><u>F-204 off service (on service)</u></b>  |                               |                 |
| F-11  | Inlet                         | Closed (Open)   |
| F-12  | Outlet                        | Closed (Open)   |
| F-15  | Drain                         | Closed          |
| <b><u>F-204 off service (on service)</u></b>  |                               |                 |
| F-13  | Inlet                         | Closed (Open)   |
| F-14  | Outlet                        | Closed (Open)   |
| F-16  | Drain                         | Closed          |

| <u>Valve</u>                             | <u>Valve Description</u> | <u>Position</u> |
|--|--------------------------|-----------------|
| <b><u>ON POOL SERVICE BED DI-</u></b>    |                          |                 |
| _____ DI-1                               | From pool                | Open            |
| _____ DI-2                               | From reactor             | Closed          |
| _____ DI-3                               | Sluice inlet             | Closed          |
| _____ DI-4                               | To pool                  | Open            |
| _____ DI-5                               | To reactor               | Closed          |
| _____ DI-6                               | Sluice outlet            | Closed          |
| _____ DI-7                               | Air supply               | Closed          |
| _____ DI-8                               | Vent                     | Closed          |
| _____ DI-9                               | Drain                    | Closed          |
| <b><u>ON PRIMARY SERVICE BED DI-</u></b> |                          |                 |
| _____ DI-1                               | From pool                | Closed          |
| _____ DI-2                               | From reactor             | Open            |
| _____ DI-3                               | Sluice inlet             | Closed          |
| _____ DI-4                               | To pool                  | Closed          |
| _____ DI-5                               | To reactor               | Open            |
| _____ DI-6                               | Sluice outlet            | Closed          |
| _____ DI-7                               | Air supply               | Closed          |
| _____ DI-8                               | Vent                     | Closed          |
| _____ DI-9                               | Drain                    | Closed          |
| <b><u>STANDBY COLUMN DI-</u></b>         |                          |                 |
| _____ DI-1                               | From pool                | Closed          |
| _____ DI-2                               | From reactor             | Closed          |
| _____ DI-3                               | Sluice inlet             | Closed          |
| _____ DI-4                               | To pool                  | Closed          |
| _____ DI-5                               | To reactor               | Closed          |
| _____ DI-6                               | Sluice outlet            | Closed          |
| _____ DI-7                               | Air supply               | Closed          |
| _____ DI-8                               | Vent                     | Closed          |
| _____ DI-9                               | Drain                    | Closed          |

STANDARD OPERATING PROCEDURES

2nd Edition, Effective Date: 5/2/89

(Revisions #1 through #24 to the October 1981 printing were incorporated.)

Revision Number 11  
Revision Date: 8/31/93

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### III.8 Check of Process Radiation Monitors

#### III.8.1 Operational Check of Secondary Coolant and Fission Product Monitors, respectively.

- A. Lower alarm setpoint until annunciator alarms.
- B. Place level switch up and adjust alarm setting to 10k cpm  $\pm$  10%. ]
- C. Lower alarm setpoint until annunciator alarms.
- D. Place level switch up and adjust alarm setting to 12k cpm  $\pm$  10%. ]

#### III.8.2 Operational Check of Stack Monitor

- A. The operator conducting the test in the West Tower shall establish communication with the control room via the intercom
- B. Place the mode switch for the iodine detector in the "T" (test) position.
- C. Verify that the **iodine pen on the stack recorder and its local meter both read** 3600 cpm  $\pm$  10% (**3240 to 3960**), and that the stack monitor high activity annunciation is received. ]
- D. Return the iodine mode switch to the "N" position.
- E. Press the "reset" button until the iodine meter and recorder readings return to normal, do not drive them to the downscale position. Reset the annunciator.
- F. Place the mode switch for the particulate/gas monitor in the "T" position.
- G. Verify that the particulate and gas pens **on the stack recorder and their local meters all read** 3600 cpm  $\pm$  10% (**3240 to 3960**), and that the stack monitor high activity annunciation is received. ]
- H. Return the particulate mode switch to "OP" position.
- I. Press the "reset" button until the particulate meter and recorder readings return to normal; do not drive it to the downscale position. Reset the annunciator.
- J. Test the low flow alarm in the control room by securing the blower.
- K. Return the blower switch to "on", verify "high" and "low" alarms cleared.

### III.9 Area Radiation Monitoring System

The area radiation monitoring system will be in operation continuously and is to be turned off only during maintenance on the system. When handling samples, or during maintenance, place the Bridge Upscale Switch in the upscale position. Ensure Bridge Upscale Switch is returned to normal position after handling samples.

The station trip points shall be set as follows:

|            |                   |  |
|------------|-------------------|--|
| Station 1  | BP North Wall     | 2 X acceptable background                    |
| Station 2  | BP West Wall      | 2 X acceptable background                    |
| Station 3  | BP South Wall     | 2 X acceptable background                    |
| Station 4  | Exhaust Plenum    | 1 mr/hr or 10 X normal operating background  |
| Station 6  | Bridge ALARA      | 300 mr/hr alert<br>10K mr/hr alarm/trip      |
| Station 7  | Bridge            | 50 mr/hr or 10 X normal operating background |
| Station 8  | Nuclepore         | 2 X normal operating background              |
| Station 9  | Fuel Vault        | 2 X normal operating background              |
| Station 10 | Room 114          | 2 X normal operating background              |
| Station 11 | Exhaust Plenum #2 | 1 mr/hr or 10 X normal operating background  |

At least once a month for stations 4, 6, 7 and 11, and once a quarter for the remaining stations, the system will be checked according to the following procedure:

NOTE: GREEN Lamp serves as Normal light and Check Source actuating switch (push to actuate source).

AMBER Lamp serves as Alert alarm (push to reset).

RED Lamp serves as High alarm (push to reset). The alert has been set up on all ARMS units except for the Bridge ALARA. ]

- A. At station 1, operate the check source pushbutton and verify that when trip point is reached, the RED alarm lamp lights at the Electronic Channel, and the RED alarm lamp lights and the AUDIBLE alarm sounds at the Remote Alarm Unit.
- B. Repeat step A for Stations 2, 3, 8, 9 and 10.

II.4.3 Providing DI Water to T-300 or the Facility Demineralized Water Tanks ] ]

DI water may be sent to T-300 or the facility DI water tanks with or without the use of the reverse osmosis unit as a DI-300 makeup supply. Due to the fact that DCW, after passing through the R.O. Unit, is much more pure than raw DCW, the R.O. Unit is normally utilized to prolong the life of the DI-300 resin regeneration. However, there are provisions for bypassing the R.O. Unit when sending DI-300 water directly to DI-200 (see VII.4.3.3).

VII.4.3.1 Providing DI Water to T-300 or the Facility DI Water Tanks with Reverse Osmosis Makeup ]

A Culligan (Polishing) bed is used to augment the R.O. unit.

- A. Open: ]
  - 1. RE-31 if supplying water to T-300. ]
  - 2. DI-21 if supplying water to facility DI water tanks. ]
- B. Place product water valve RO-10 to the DI water system position.  
NOTE: The handle points in the direction of the open port.
- C. Check open the following R.O. Unit valves: RO-1, RO-2, RO-5, RO-7, RO-8, RO-9 and RO-13.
- D. Open outlet valve (RO-11) from Culligan bottles.
- E. Open DI-5.
- F. Turn conductivity meter to "ON" and place auto valve switch to "AUTO" (first auto valve should open). If sending to T-300, place high level cutout switch to cutout if high level shutdown exists in facility DI tanks. ] ]
- G. Push the R.O. Unit start button.
- H. Push reset button under conductivity meter (second auto valve should open). There should be a 3 to 6 second delay before R.O. Unit starts. (Pressure should come up to 190-200 psig.)  
CAUTION: If valves do not open, the conductivity is at or above alarm setpoint. Place normal/bypass switch to "BYPASS".
- I. Flush R.O. Unit through DI-5 until conductivity falls below alarm setpoint.
- J. Open auto valve isolation valve (DI-17) and shut DI-5.
- K. Place normal/bypass switch to "NORMAL" if required.
- L. Fill out the DI water log.

Normally, the water inlet temperature will not require adjustment and is set at approximately 25 to 30°C. Allow at least 30 minutes of running time to stabilize temperature prior to determining if an adjustment is needed.

TO SECURE SENDING WATER

- A. Push the R.O. Unit off button.
- B. Place auto valve switch to "CLOSE." Turn conductivity meter to "OFF" (both auto valves should be closed).
- C. Shut auto valve isolation valve (DI-17).
- D. Shut Culligan bottles discharge valve (RO-11).
- E. Place product water valve RO-10 to the flush or drain position.
- F. Shut:

- 1. RE-31 if supplying water to T-300.
- 2. DI-21 if supplying water to facility DI water tanks.

CAUTION: The following valves should be left open while the unit is OFF:

|      |       |
|------|-------|
| RO-2 | RO-7  |
| RO-5 | RO-8  |
| RO-1 | RO-9  |
| RO-6 | RO-13 |

- G. Fill out the DI water log.

When the unit is not in use, DO NOT UNPLUG, PLACE IN STANDBY ONLY. DO NOT SECURE SUPPLY WATER.

NOTE: If for any reason the unit must be turned off or the supply water secured, this condition MUST NOT exist for more than 60 hours or damage will occur to the filter membranes (see technical manual #476 for details).

No regular maintenance is required to operate this unit. For any repair or maintenance, refer to the technical manual.

VII.4.3.2 Providing DI Water to T-300 Without Reverse Osmosis Unit Makeup Transferred to SMP-22.

VII.4.3.3 Providing DI Water to DI200 Units Using R300 Bed Transferred to SMP-22.

- C. Material which may be irradiated in the p-tube system includes water, plant and animal tissue and fluids, bone, air filters, soils, rocks, soil extracts, coal, paper, meteorites, fibers, dried paint, safe insulation and glass. Pure elements, alloys and compounds not exempted in D below may also be irradiated subject to the activity limitations in A.
- D. Unless it is specifically authorized in the experimenter's RUR, the following materials will not be irradiated in the p-tube system:
- E. 1. Natural uranium; ]
2. Special nuclear materials as defined in Title 10, Part 70, Paragraph 70.4m of the Federal Code of Regulations (i.e., plutonium, uranium-233, or uranium enriched in isotope 233 or 235);
3. Pure elements: Li, Na, K, Rb, Cs, Ca, Sr, Ba, Hg, Os, H, O, F, Ne, Ar, Kr, Xe, and P;
4. Compounds:  $\text{NH}_4\text{NO}_3$ ,  $\text{CaC}_2$ ,  $\text{CaO}$ , perchlorates, permanganates,  $\text{Na}_2\text{O}$ , and  $\text{Na}_2\text{O}_2$ ;
5. Materials which chemically react with water to produce undesirable quantities of heat and pressure;
6. Any explosive, flammable, combustible, or toxic materials.
- F. Capsules may be run shielded with cadmium or boron (as boron, BC, or BN) but weight and time are restricted due to the heat generated and their reactivity effect on the reactor. The experimenter shall take measures to insure the heat generated can be dissipated without causing damage to the rabbit or sample. The following limitations apply to shielded capsules in addition to the activity limits of Section VIII.3.2.A: ]

### VIII.3.2. Sample Limitations (cont'd)

1. The authorized p-tube user will inform the control room he/she is going to run shielded capsules and will insert the rabbit so that the cap is on top when the rabbit is in the reactor.
2. Cadmium shielded capsules:
  - a. 5 or less grams of cadmium may be run for up to 30 minutes.
  - b. 50 or less grams of cadmium may be run for up to 10 seconds in Row 1 or 20 seconds in Row 2.
3. Boron shielded capsules:

NOTE: The weight limit is only on the Boron, i.e., the carbon weight in BC does not count towards the weight limit.

- a. The single boron shielded capsule with between 10 to 15 grams of boron may be run for up to 15 seconds in Row 1 or up to 20 seconds in Row 2.
  - b. The double boron shielded capsule with between 15 and 20 grams of boron may be run for up to 10 seconds in Row 1.
- G. Except for the boron or cadmium shielded samples, the controlling factor for determining the weight and time limits of a sample to be irradiated in the p-tube is the activity limitation of Section A. If the activity limits do not further restrict a sample's size, the following weight limits shall apply:
1. For irradiation times up to 30 minutes, the maximum weight of irradiated materials in one rabbit will be 2 grams with two exceptions:
    - a. A maximum of 10 grams of water or dried feces;
    - b. Only 1 mg of chemical compounds in solution.
  2. For irradiation times of 30 minutes to 1 hour, the maximum weight of irradiated materials in one rabbit will be 1 gram with two exceptions:
    - a. A maximum of 10 grams of water or dried feces;
    - b. Only 500  $\mu\text{g}$  of chemical compounds in solution.

MURR SITE EMERGENCY PROCEDURES AND  
FACILITY EMERGENCY PROCEDURES

Revision Number 13  
Revision Date: 7/8/93

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SEP-2UNUSUAL EVENT PROCEDUREACTIONS LEVELS:

IF there is:

- a. Report or observation of severe natural phenomenon.
- b. Threats to or breaches of security. [See REACTOR EMERGENCY PROCEDURE (REP-22).]
- c. Concentration of airborne radioactivity at the stack monitor exceeding 3800 MPC when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).]

NOTE: Use Overlay I to determine extent of activity for iodine and particulate. Use Overlay II to determine extent of gaseous activity.

- d. The projected concentration of airborne radiological effluents at the distance corresponding to the nearest site boundary exceeding 10 MPC when averaged over 24 hours.
- e. Prolonged fire or explosion within the facility that can result in a release of radioactivity that would cause exposures of the public or staff approaching 1 rem whole body or 5 rem thyroid.
- f. Other plant conditions exist that warrant **ensuring** emergency personnel are available to respond to an emergency to prevent exposures of 1 rem whole body or 5 rem thyroid to the public or staff. ]

THEN at least an UNUSUAL EVENT condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization (FEO), as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.
2. Operations shall provide information to the EMERGENCY DIRECTOR/ EMERGENCY COORDINATOR.
3. If airborne activity is involved, continue with step 4. If not, go to step 7.
4. Time and date stack monitor **chart** for reference. ]

CORRECTIVE ACTIONS:

1. If airborne activity is involved, determine source of airborne radioactivity and try to reduce or eliminate the source.

a. REACTOR

- (1) Check fission product monitor.
- (2) Check room 114 ARMS.
- (3) Check pool for gas releases.
- (4) **Check dose rate on room 114 filter bank.** ]

Actions to Consider:

- (1) Sample primary
- (2) Procedure REP-20, High Activity Levels in Primary
- (3) Reactor Isolation (FEP-2)
- (4) Area Evacuations
- (5) Portable air monitor in room 114

b. REACTOR EXPERIMENTS (NUCLEPORE, BEAMPORTS, P-TUBES)

- (1) Check ARMS
- (2) Check changes on off-gas recorders when securing P-tube blowers.
- (3) Check Nuclepore alarm.
- (4) Check air monitors on beamport floor.

Actions to Consider:

- (1) Perform air samples with portable monitor.
- (2) Shut down experiment.
- (3) Shut down reactor.
- (4) Reactor Isolation

c. HOTCELL

- (1) **Check dose rates at hotcell filter bank.** ]

Actions to Consider:

- (1) shut hotcell valve.

CORRECTIVE ACTIONS:

1. If the facility was evacuated in Step 8 of IMMEDIATE ACTIONS, continue. IF NOT, go to step 2.
  - a. Commence external surveys of the reactor laboratory building to detect leakage of airborne radioactivity and locate the source radioactivity.
  - b. Commence air sampling at 400 meters downwind of facility as per EMERGENCY AIR SAMPLING PROCEDURE (SEP-6). ]
  - c. Evaluate results of surveys to determine possible reentry to parts of facility for further investigation, if necessary.
  - d. IF leakage concentrations exceed 19,000 MPC averaged over 24 hours, the EMERGENCY DIRECTOR should consider evacuation of USDA, Science Instrument Shop, Dalton Research Center, and Blood Bank, as per SITE AREA EVACUATION PROCEDURE (SEP-5).

IF NOT, EMERGENCY DIRECTOR should evaluate de-escalating to UNUSUAL EVENT classification.

2. Determine source of airborne radioactivity and try to reduce or eliminate the source.
  - a. REACTOR
    - (1) Check fission product monitor.
    - (2) Check room 114 ARMS.
    - (3) Check pool for gas releases.
    - (4) **Check dose rate on room 114 filter bank.** ]

Actions to Consider:

- (1) Sample primary
- (2) Procedure REP-20, High Activity Levels in Primary
- (3) Reactor Isolation (FEP-2)
- (4) Area Evacuations
- (5) Portable air monitor in room 114

b. REACTOR EXPERIMENTS (NUCLEPORE, BEAMPORTS, P-TUBES)

- (1) Check ARMS
- (2) Check changes on off-gas recorders when securing P-tube blowers.
- (3) Check Nuclepore alarm.
- (4) Check air monitors on beamport floor.

Actions to Consider:

- (1) Perform air samples with portable monitor.
- (2) Shut down experiment.
- (3) Reactor Isolation

c. HOTCELL

- (1) Check dose rates at hotcell filter bank. ]

Actions to Consider:

- (1) Shut hotcell valve.

d. LABORATORIES

- (1) Determine which laboratory is the source of release, by checking radiation levels in quadrant exhaust ducting.
  - (a) Southwest Quadrant
  - (b) Northwest Quadrant
  - (c) Northeast Quadrant

Actions to Consider:

- (1) Throttle flow from laboratory quadrant to reduce release rate to less than Technical Specification's limits.
- (2) Area Evacuations

SEP-7PUBLIC INFORMATION PROCEDURE

NOTE: The MU News Bureau shall be activated to handle the release of public information as required in the ALERT or SITE AREA EMERGENCY procedures; whenever offsite emergency assistance is requested via 911; or whenever deemed appropriate by the EMERGENCY DIRECTOR.

## A. INITIAL RELEASE OF PUBLIC INFORMATION

1. The Emergency Status Report shall be completed and approved by the EMERGENCY DIRECTOR.
- 2a. During normal University office hours, activate the MU News Bureau by calling 882-6211, 882-6214 (**Ken Brogdon**) or 882-6217 (Jim Muench). ]
- 2b. At other times, call the following list of MU News Bureau staff in order until one of the individuals listed is reached (NOT their spouse, children, etc.).
 

|                           |                 |   |
|---------------------------|-----------------|---|
| 1) Ken Brogdon            | 442-5260        | ] |
| 2) Jim Muench             | 443-0879        | ] |
| 3) <b>Connie Mitchell</b> | <b>442-6166</b> | ] |
3. Read the Emergency Status Report as approved by the EMERGENCY DIRECTOR to the MU News Bureau staff member and answer any questions concerning definitions, terms, units, etc.
4. Record other questions that the MU News Bureau staff member may have. Enter the name of the MU News Bureau staff member contacted and give the completed report to the EMERGENCY COORDINATOR to be kept with the records of the EMERGENCY.

5. The MU News Bureau staff member contacted should verify a call concerning an emergency at the University of Missouri Research Reactor by calling 882-4211 or 874-4119 and asking to speak to a member of the Facility Emergency Organization (FEO). If the person answering the phone does not know who is in the FEO, then ask for anyone from the Director's Office, Operations, Health Physics/Reactor Chemistry groups. The individuals in these groups are listed below in alphabetical order. After verifying the person's identity by asking for his social security number, the emergency call can be verified.

VERIFICATION LIST FOR MURR EMERGENCIES

| <u>Name</u>           | <u>Soc. Sec. No.</u> | <u>Name</u>      | <u>Soc. Sec. No.</u> |
|-----------------------|----------------------|------------------|----------------------|
| Chuck Anderson        |                      | Charlie McKibben |                      |
| Rex Ayers             |                      | Walt Meyer       |                      |
| Joe Baskett           |                      | Steve Morris     |                      |
| Rita Bonney           |                      | Paul Muren       |                      |
| Kenneth Beamer        |                      | Phil Neel        |                      |
| Barry Bezenek         |                      | Willy Oldham     |                      |
| Chester Edwards       |                      | Dave Peeler      |                      |
| John Ernst            |                      | Derek Pickett    |                      |
| Christine Errante     |                      | Leslie Powell    |                      |
| Les Foyto             |                      | Bill Reilly      |                      |
| John Fruits           |                      | Tony Schoone     |                      |
| Greg Gunn             |                      | Jim Schuh        |                      |
| <b>Andrew Hartweg</b> | J                    | Tom Seeger       |                      |
| Robert Hudson         |                      | Andrea Shipp     |                      |
| Rolly Hultsch         |                      | Vickie Spate     |                      |
| Brenda Johnson        |                      | Ray Stevens      |                      |
| Vernon Jones          |                      | Nolan Tritschler |                      |
| Mike Kilfoil          |                      | Robert Walker    |                      |
| Ron Kitch             |                      | Mike Wallis      |                      |
| Sue Langhorst         |                      | Tim Warner       |                      |

6. MU News Bureau personnel contacted will determine the need for staffing and equipping an emergency information center and will call in the required staff and arrange for necessary facilities.
7. MU News Bureau personnel will inform news media and others of the public, as necessary, of the emergency.
8. If possible, a MU News Bureau staff member will be sent on site to assist the EMERGENCY DIRECTOR with the release of information.

SEP-10

EMERGENCY DOSIMETERS FOR OFF-SITE PERSONNEL

PURPOSE

This procedure provides for radiation dosimeters for off-site personnel responding to a call under the MURR Emergency Plan.

PROCEDURE

The EMERGENCY COORDINATOR will assign a person to issue self-reader pocket chambers (PC) and film badges to off-site personnel as they arrive at MURR.

A supply of PCs and film badges are maintained in the lobby at the reception desk. A second supply is maintained in the Health Physics Office. A third source of PCs is the film badge racks in the hallway near the lobby. The PCs in the badge racks are assigned to individuals and these would be used only if the lobby and Health Physics Office supplies are inadequate. The film badges in the badge rack will not be assigned to off-site personnel. If the two badge supplies are inadequate, only a PC will be assigned and Health Physics will issue a spare film badge as soon as possible.

Form SEP-10 Pocket Chamber and Film Badge Record will be stored at the reception desk. When PCs and film badges are issued to off-site personnel, the PC and badge identification will be recorded on the form. If time permits, other information indicated on the form will be recorded. In any case, when the PC and badge are returned to Health Physics, the remaining information will be recorded for permanent record and for evaluation by Reactor Health Physics Office.

SEP-11MONITORING PLANNED EXPOSURES IN EXCESS OF LIMITS IN 10CFR20

NOTE: The EMERGENCY DIRECTOR must approve each volunteer to exceed exposure limits of 10CFR20.

PURPOSE

This procedure provides the guidelines for monitoring, dosimetry and records for persons who volunteer for lifesaving and accident mitigating activities which could result in planned radiation exposures in excess of 10CFR20 limits.

GUIDELINESA. Emergency Exposure Guidelines

1. A volunteer may be authorized to receive up to 75 rem to save human life.
2. A volunteer may be authorized to receive up to 25 rem to prevent radiation exposures to members of the general public in excess of the following Protection Action Guides (PAGs).

The Protective Actions for all classifications are based upon a PAG of 1 rem dose equivalent for whole body and 5 rem dose equivalent thyroid to members of the general public and MURR staff on-site.

B. Personnel Selection Considerations

1. Individual is a volunteer (preferably 45 years or older).
2. Individual is familiar with the radiological consequences of emergency radiation exposures.
3. Women of childbearing age shall not take part (Reg. Guide 8.13).

C. Self-reader Dosimeters and Locations

| <u>Type</u> | <u>Range (mr)</u> | <u>Location</u>           |
|-------------|-------------------|---------------------------|
| PC          | 0 - 200           | Receptionist Desk - Lobby |
| PC          | 0 - 200           | Health Physics Office     |
| PC          | 0 - 200           | Film Badge Racks          |
| PC          | 0 - 200           | Emergency Lockers         |
| PC          | 0 - 200,000       | <b>Emergency Lockers</b>  |

NOTE: PC = Self-reader Pocket Chamber

PROCEDURE

NOTE: Although it is preferable to perform and document the steps presented below prior to emergency workers receiving the exposure, the situation (e.g., lifesaving measures) may require the EMERGENCY DIRECTOR to verbally authorize the exposure and ensure completion of documentation when time permits.

1. Ensure that the dose rate in the task area is known or measurable.
2. Ensure that volunteer has assigned film badge.
3. Complete Worksheet E giving careful attention to item C considerations.
4. Assign the volunteer a self-reader pocket chamber or equivalent immediate readout monitor with a range double the anticipated total exposure for the assignment.
5. The EMERGENCY DIRECTOR or a delegate shall obtain the exposure recorded by the readout device at a frequency that **ensures** adequate control to prevent exposures in excess of the planned limits for the volunteer. ]
  - a. The exposure received at each reading shall be recorded on Worksheet E.

FOLLOW-UP

1. Expedite processing of volunteer's film badge to verify total exposure as indicated by self-reading dosimeters.
2. If individual's dose equivalent exceeds any 10 CFR 20 limits, they should be examined by a physician to determine the need, extent and nature of medical surveillance or treatment.

REPORTING REQUIREMENTS

Complete reporting requirements of 10 CFR 20.403.

EMERGENCY PROCEDURE  
EMERGENCY CALL LIST

| Director's Office |           |
|-------------------|-----------|
|                   | Phone No. |
| J. Rhyne          | 442-4967  |
| J. C. McKibben    | 442-6728  |

| Reactor Operations |              |
|--------------------|--------------|
|                    | Phone No.    |
| W. Meyer           | 442-7675     |
| T. Schoone         | 443-8862     |
| R. Hultsch         | 442-6653     |
| C. Anderson        | 696-5506     |
| B. Bezenek         | 445-5680     |
| G. Gunn            | 875-1162     |
| N. Tritschler      | 474-9388     |
| L. Foyto           | 446-0491     |
| J. Fruits          | 474-0774     |
| A. Hartweg         | 445-1557 ]   |
| R. Hudson          | 445-6769     |
| V. Jones           | 445-2543     |
| P. Muren           | 874-0219 ]   |
| P. Neel            | 442-8693     |
| W. Oldham          | 474-0987     |
| R. Walker          | 443-0970     |
| M. Wallis          | 696-1097     |
| T. Warner          | 816-882-6740 |

| Health Physics/Rx. Chemistry |            |
|------------------------------|------------|
|                              | Phone No.  |
| S. Langhorst*                | 442-3534   |
| R. Stevens                   | 442-2539   |
| J. Ernst                     | 445-5621   |
| J. Schuh                     | 449-0992   |
| R. Ayers                     | 474-7907   |
| W. D. Pickett                | 474-0709   |
| A. Shipp                     | 442-4304 ] |

| Facilities Operations |              |
|-----------------------|--------------|
|                       | Phone No.    |
| C. Edwards            | 443-7529     |
| D. Peeler             | 316-848-2471 |
| K. Beamer             | 682-5499     |
| R. Kitch              | 875-0664 ]   |
| C. Kribbs             | 682-3980     |
| T. Seeger             | 474-3891     |
| J. Baskett            | 474-2046     |

| Staff Resource Personnel |            |
|--------------------------|------------|
|                          | Phone No.  |
| S. Morris                | 445-4217   |
| V. Spate                 | 657-9450   |
| C. Baskett               | 474-2046   |
| M. Glascock              | 443-4172   |
| B. McCracken             | 449-7731   |
| W. Oladiran              | 443-5658   |
| D. Nickolaus             | 443-0502   |
| G. Ehrhardt              | 445-3570   |
| A. Ketring               | 657-9614   |
| B. Yelon                 | 445-8147   |
| M. Kilfoil               | 449-2524 ] |
| S. Gunn                  | 443-2125   |
| L. Krueger               | 442-0740   |
| T. Sturvick              | 445-4038   |

| Emergency Support Organizations                                      |                         |
|--|-------------------------|
|  | Phone No.               |
| <u>UMC Police</u>  | 882-7201                |
| <u>Columbia Fire Department</u>                                      | 9-911                   |
| <u>UM Hospital &amp; Clinics</u>                                     |                         |
| Emergency Services   | 882-6003                |
| Ambulance  | 882-6128 or 9-911       |
| Walk-In (Emergency Center)   | 882-8091                |
| <u>UMC Health Physics (Office)</u>                                   | 882-7221                |
| Dr. Phil Lee (Home)  | 445-5275                |
| Jamieson Shotts (Home)   | 474-2194                |
| David Spate (Home)   | 657-9450                |
| <u>MU News Bureau</u>  | 882-6211                |
| See Public Information Procedure<br>for other phone numbers (SEP-7). | 882-6214<br>or 882-6217 |
| <u>State Emergency Management Agency (SEMA)</u>                      | 314-751-2748            |
| <u>NRC Washington, DC</u>  | 301-951-0550            |
| <u>NRC Region III</u>  | 708-790-5500            |
| <u>American Nuclear Insurers</u>                                     | 203-561-3433            |

\*On leave until January 1994.

Rev. 7/8/93

App'd

*Wam*

FACILITY EMERGENCY PROCEDURES  
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UMH&C (Hospital & Clinics) - RADIATION DISASTER PLAN

## FEP - DESCRIPTION OF RADIATION ALARMS AND PERSONNEL RESPONSE

| System Responsible for Alarm    | Location of Sensors  | Audible Location       | Type of Alarm          | Facility Staff Personnel Response                                | Non-Staff Personnel Response                  |
|---------------------------------|--|------------------------|------------------------|--|---|
| 1. Isolation System             | a. Manual Switch in Control Room<br>b. Air plenum (ARM) (fifth level)<br>c. Reactor bridge (ARM)<br>d. Air plenum BU monitor | Throughout Containment | Horn ▲ ●               | Execute reactor isolation plan                                   | Execute reactor isolation plan                |
| 2. Evacuation System            | a. Control Room<br>b. Front Lobby  | Throughout Facility    | Horn ▲ ●               | Execute facility evacuation plan                                 | Execute facility evacuation plan              |
| 3. Particulate Monitor          | Variable in Containment  | Local                  | Bell and red light †   | Cause immediate area to be vacated and notify Reactor Operations | Vacate containment; Notify Reactor Operations |
| 4. Area Radiation Monitor (ARM) | a. South wall-BP Floor<br>b. West wall-BP Floor<br>c. North wall-BP Floor<br>d. Fuel Storage Room<br>e. Heat Exchanger Room  | Local; Control Rm      | Buzzer and red light ▲ | Cause immediate area to be vacated and notify Health Physics     | Vacate immediate area                         |
| 5. Hand and Foot Monitors       | Basement exit (outer corridor)   | Local                  | Buzzer and Indication  | Notify Health Physics ■  | Notify Health Physics ■                       |
|                                 | West corridor  | Local                  | Buzzer and red light   | Notify Health Physics ■  | Notify Health Physics ■                       |
| 6. Portal Monitor               | East Exit  | Local                  | Bell and Indication    | Notify Health Physics ■  | Notify Health Physics ■                       |
| ▲                               | Bell or buzzer and red light in Control Room   |                        |                        |  |   |
| ●                               | Flashing red light near containment entrance   |                        |                        |  |   |
| †                               | Control Room annunciator buzzer and light  |                        |                        |  |   |
| ■                               | After normal working hours, notify Reactor Operations  |                        |                        |  |   |

I. PERSONNEL WITH PREASSIGNED TASKS  
(Facility Emergency Organization Members)

A. IMMEDIATE ACTIONS:

The responsibility for the overall direction in the event of an emergency shall rest with the EMERGENCY DIRECTOR.

In the event of a Facility evacuation during normal working hours, the following people shall report to the reactor lobby: the Facility Director, Associate Director, Reactor Manager, Manager of Reactor Health Physics/Reactor Chemistry, Machine and Electronics Shop Supervisors, and Duty Shift Supervisor.

The responsibility for EMERGENCY DIRECTOR shall be assumed. The EMERGENCY DIRECTOR shall ascertain the availability of personnel required to execute the emergency plan and shall appoint an EMERGENCY COORDINATOR. He shall investigate the cause of the alarm and the magnitude of the incident, and shall direct those activities necessary to correct the emergency situation. After the emergency is terminated, he shall direct the procedures necessary to restore normal operation.

The EMERGENCY COORDINATOR shall ascertain that the reactor ] containment building, the Facility laboratories, and the mechanical equipment room, and below grade areas, have been vacated and secured. He will have the laboratory ventilation fans secured. He shall maintain a roster of all persons released from the site by the EMERGENCY DIRECTOR. If the pneumatic blower system was in use during the emergency, he shall insure that the samples being irradiated are returned to the laboratory and then have the blowers secured at the local lighting panel (#32). He shall ensure a record of the events following the emergency is maintained.

The DUTY OPERATOR shall perform or have performed the following tasks before leaving containment: (Do NOT attempt to correct any abnormalities at this time.)

- A. Verify that the reactor has scrammed as indicated by the instrumentation.
- B. Verify that all shim rods have bottomed as indicated by the console lights.
- C. Verify that the containment has sealed as indicated by the ventilation door and the exhaust valve lights.

II. PERSONNEL WITHOUT PRE-ASSIGNED TASKS:

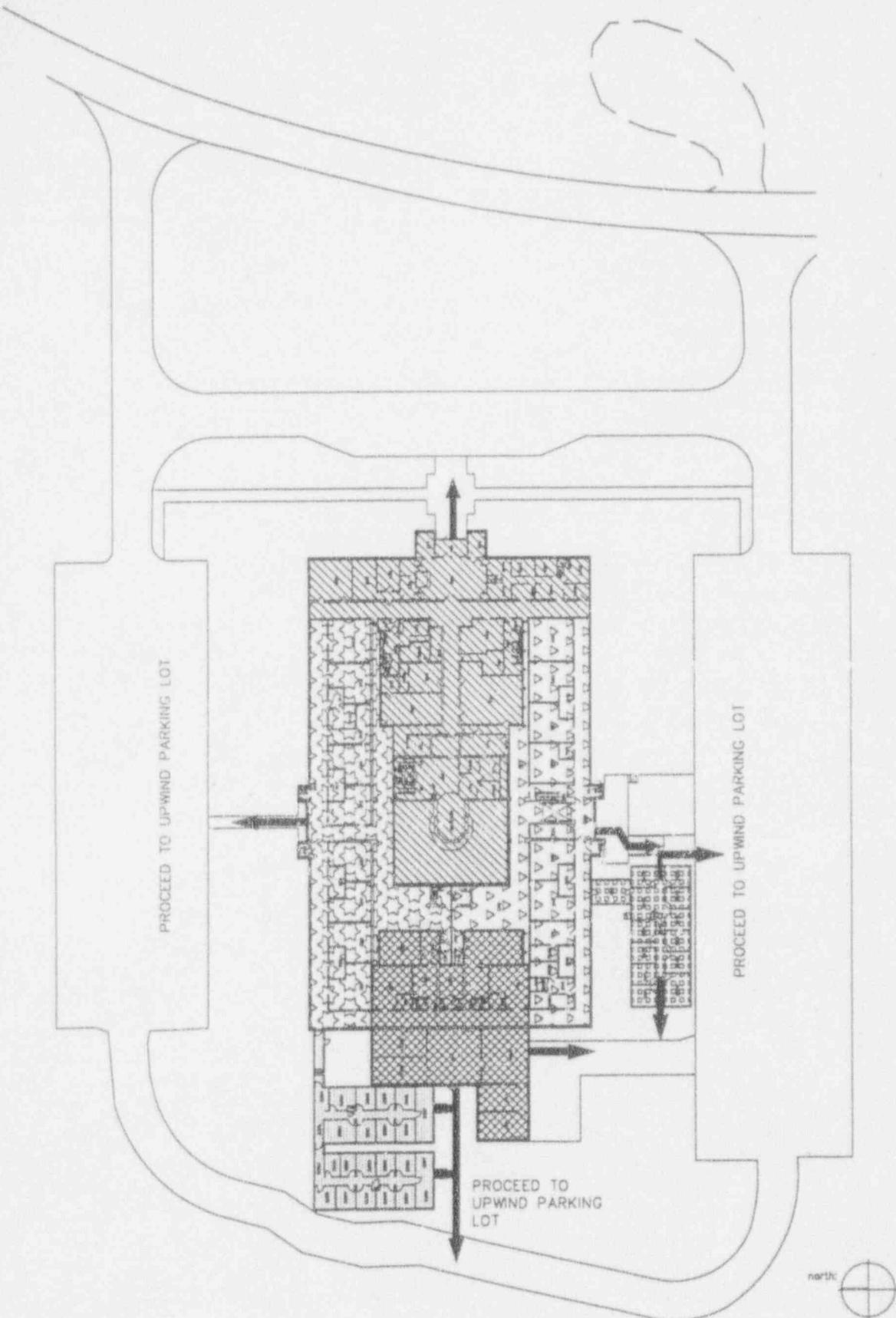
(Staff other than Facility Emergency Organization members)

A. IMMEDIATE ACTIONS:

1. Upon hearing the evacuation alarm, personnel shall proceed to points beyond the area bounded by the outer perimeter of the reactor laboratory building.
2. TOUR GUIDES shall be responsible for the safe evacuation of visitors in their charge from the Facility in accordance with the evacuation routes in this plan. VISITORS shall be monitored by Health Physics Technicians as per HP-20 before being released to leave the site.
3. EXPERIMENTERS who are conducting experiments in containment (including pneumatic tube users) shall render their experimental apparatus safe for unattended operation. They shall be responsible for the safe evacuation of visitors in their charge from the facility in accordance with the evacuation routes in this plan.
4. EVACUATION ROUTES (See the map of the routes on Page 5):
  - A. All personnel within the containment building will exit the containment building and proceed through the east door of the laboratory building and then go to the upwind parking lot.
  - B. All laboratory personnel, support personnel, and guests exterior to the containment building will leave the facility through the nearest exit (north, east, west, or south doors) and then proceed to the upwind parking lot.
5. Once outside, personnel shall note the wind direction indicator at the top of the containment building east tower and proceed to the upwind parking lot.

B. SUBSEQUENT ACTIONS:

1. All staff personnel shall remain on standby, unless released by the EMERGENCY DIRECTOR, to provide special services that may be required to restore normal operation.
2. All staff personnel shall be monitored by Health Physics Technicians as per procedure HP-20 before being released to leave the site.
3. A roster of all released personnel will be maintained by the EMERGENCY COORDINATOR.



EVACUATION ROUTES, RESEARCH REACTOR FACILITY

FIGURE FEP-1

FEP-3(a)  
CONTROL ROOM RESPONSE TO ALPHA LABORATORY FIRE

NOTE: Throughout this procedure continue to monitor stack exhaust monitor, Alpha Laboratory exhaust monitor (alpha-6) or Alpha Laboratory room monitor (alpha-3) for indication of airborne radioactivity, as appropriate.

1. If a fire is detected by fire alarm or reported in the Alpha Laboratory, the shift supervisor (or senior licensed person in control) **will verify and** call the Columbia Fire Department. ]
2. The shift supervisor will activate the Facility Emergency Organization by page system (**or after hours by Emergency Call List**) and provide warning to stay clear of facility basement. ]
3. The Emergency Director will determine nature and specific location of fire (i.e., if fire is in glove box or equipment exterior to glove box).
4. If fire cannot be put out immediately with local fire extinguishers, the reactor will **be** shut down to focus attention on the fire. ]
5. Ensure Alpha Laboratory doors are shut and personnel are out of the laboratory. If no experimenter is present, call the on-call experimenter as soon as time permits.
6. **If there is a likelihood of the fire spreading through the ventilation system**, secure EF-13 and EF-14 at breaker on **the** emergency distribution center (in north inner corridor). ]
7. Secure electrical power to Alpha Laboratory at following locations:
  - a. Breaker #13 or UPS #2 - in control room (this secures power to the argon glove box **and deactivates the glove box exhaust valves in their current position**). ]
  - b. Breaker #17 on 120/208 V distribution center - in north inner corridor (this secures power to LP-34 which will secure lights and receptacles).
  - c. Breaker #2 on emergency power panel - in north inner corridor (this secures power to ELP #2 outside Alpha Laboratory, which will secure Alpha Laboratory supply and exhaust fans).
8. Secure ventilation supply fan SF-1, north RTAH, south RTAH, at MCC-3 and check closed all fire doors.

MURR SITE EMERGENCY PROCEDURES AND  
FACILITY EMERGENCY PROCEDURES

Revision Number 14  
Revision Date: 12/28/93

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MURR EMERGENCY PROCEDURES - SEP/FEP SECTIONS

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|                         | 2                  | 1/8/85              | Emergency Center Radiation Disaster Plan |                    |                     |

SEP-1ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE

## I. FACILITY EMERGENCIES:

1. The Facility Emergency Organization (FEO) shall be activated as per the Facility Emergency Procedures (FEP) for each FACILITY EMERGENCY CLASSIFICATION:
  - a) Facility Evacuation
  - b) Reactor Isolation
  - c) Fire
  - d) Medical
  - e) Security [SAFEGUARDS INFORMATION AS PER 10CFR50.34(e)]
2. In addition to the procedures for each FACILITY EMERGENCY CLASSIFICATION, an assessment of off-site consequences shall be determined.

## II. EMERGENCIES WITH POSSIBLE OFF-SITE CONSEQUENCES:

1. The duty shift supervisor or individual authorized to assume the Emergency Director position shall determine the need to activate the FEO for emergencies with possible off-site consequences. This need will be based upon the action levels specified for the minimum classification, UNUSUAL EVENT. These action levels are:
  - a. Report or observation of severe natural phenomenon.
  - b. Threats to or breaches of security.
  - c. Concentration of airborne radioactivity at the stack monitor exceeding **20,000 AEC\*** when averaged over 24 hours. ]
  - d. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **15 mrem whole body accumulation in 24 hours.** ]
  - e. Prolonged fire or explosion with the facility that can result in a release of radioactivity that would cause exposures of the public or staff approaching 1 rem whole body or 5 rem thyroid.
  - f. Other plant conditions exist that warrant **ensuring** emergency personnel are available to respond to an emergency to prevent exposures of 1 rem whole body or 5 rem thyroid to the public or staff. ]

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

TABLE I  
ACTION LEVELS FOR EMERGENCY CLASSES

Unusual Event

1. Report or observation of severe natural phenomenon.
2. Threats to or breaches of security.
3. Concentration of airborne radioactivity at the stack monitor exceeding **20,000 AEC\*** when averaged over 24 hours. ]
4. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **15 mrem whole body accumulated in 24 hours.** ]
5. Prolonged fire or explosion within the facility that can result in a release of radioactivity that would cause exposures of the public or staff approaching 1 rem whole body or 5 rem thyroid.
6. Other plant conditions exist that warrant **ensuring** emergency personnel are available to respond to an emergency to prevent exposures of 1 rem whole body or 5 rem thyroid to the public or staff. ]

Alert

1. Concentration of airborne radioactivity at the stack monitor exceeding **100,000 AEC\*** when averaged over 24 hours. ]
2. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **75 mrem whole body accumulated in 24 hours.** ]
3. Radiation levels at the distance corresponding to the nearest site boundary of 20 mrem/hr for 1 hour whole body or 100 mrem thyroid dose.
4. Loss of physical control of the facility.
5. Other plant conditions exist with a level of significance of a major failure of fuel cladding, but primary and containment boundaries exist to reduce releases.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

TABLE I (Cont'd)  
ACTION LEVELS FOR EMERGENCY CLASSES

Site Area Emergency

1. Concentration of airborne radioactivity at the stack monitor exceeding **500,000 AEC\*** when averaged over 24 hours. ]
2. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **375 mrem whole body accumulated in 24 hours.** ]
3. Radiation levels at the distance corresponding to the nearest site boundary of 100 mrem/hr for 1 hour whole body or 500 mrem thyroid dose.
4. Other plant conditions exist with a level of significance of major fuel damage and conditions that indicate actual or imminent failure of containment integrity and primary system integrity.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

SEP-2UNUSUAL EVENT PROCEDUREACTIONS LEVELS:

IF there is:

- a. Report or observation of severe natural phenomenon.
  - b. Threats to or breaches of security. [See REACTOR EMERGENCY PROCEDURE (REP-22).]
  - c. Concentration of airborne radioactivity at the stack monitor exceeding **20,000 AEC\*** when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).] ]
- NOTE: Use **overlays** to determine extent of activity for iodine, particulate, **and gas**. ]
- d. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **15 mrem whole body accumulated in 24 hours**. ]
  - e. Prolonged fire or explosion within the facility that can result in a release of radioactivity that would cause exposures of the public or staff approaching 1 rem whole body or 5 rem thyroid.
  - f. Other plant conditions exist that warrant ensuring emergency personnel are available to respond to an emergency to prevent exposures of 1 rem whole body or 5 rem thyroid to the public or staff.

THEN at least an UNUSUAL EVENT condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization (FEO), as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.
2. Operations shall provide information to the Emergency Director/Emergency Coordinator.
3. If airborne activity is involved, continue with step 4. If not, go to step 7.
4. Time and date stack monitor chart for reference.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

CORRECTIVE ACTIONS: (Cont'd)

]

d. LABORATORIES

- (1) Determine which laboratory is the source of release by checking radiation levels in quadrant exhaust ducting.
  - (a) Southwest Quadrant
  - (b) Northwest Quadrant
  - (c) Northeast Quadrant

Actions to Consider:

- (1) Throttle flow from laboratory quadrant to reduce release rate to less than Technical Specification limits.
- (2) Area Evacuations

SUBSEQUENT ACTIONS:

1. Change stack filters when chart reading exceeds  $3 \times 10^5$  cpm. Reevaluate chart readings to determine if release rate is increasing/decreasing. Record time of filter changeout.
2. Evaluate results of correction and subsequent actions to determine need to escalate/de-escalate the emergency classification.
3. Keep record of actions and evaluations and time they were done for documentation. Use procedure worksheets.
4. Notify NRC, **Headquarters Operations Officer, Washington, DC** [301-951-0550] that an UNUSUAL EVENT has occurred within one hour after event is classified or reclassified. (Use Worksheet C)
5. Notify American Nuclear Insurers (ANI) [203-561-3433] that an UNUSUAL EVENT has occurred. (Use information in Worksheet C)
6. Notify State Emergency Management Agency (SEMA) [314-751-2748] that an UNUSUAL EVENT has occurred. (Use information in Worksheet C)

RECOVERY ACTIONS:

1. Evaluate potential radiological effects to on-site and off-site personnel before returning access to specific areas effected by UNUSUAL EVENT emergency.
2. Procedures shall be written and approved for handling significant recovery evolutions.

NOTE: During recovery operations, personnel exposures to radiation should be maintained with 10CFR20 limits.

SEP-3  
ALERT PROCEDURE

ACTIONS LEVELS:

IF there is:

- a. Concentration of airborne radioactivity at the stack monitor exceeding **100,000 AEC\*** when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).] ]

NOTE: Use **overlays** to determine extent of activity for iodine, particulate, **and gas**. ]

- b. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **75 mrem whole body accumulated in 24 hours**. ]
- c. Radiation levels at the distance corresponding to the nearest site boundary of 20 mrem/hr for 1 hour whole body or 100 mrem thyroid dose.
- d. Loss of physical control of the facility.
- e. Other plant conditions exist with a level of significance of a major failure of fuel cladding, but primary and containment boundaries exist to reduce releases.

THEN at least an ALERT condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization, as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.
2. Operations shall provide information to the Emergency Director/Emergency Coordinator.
3. Time and date stack monitor charts for reference.
4. Shut down the reactor.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

**IMMEDIATE ACTIONS:** (Cont'd)

1

5. Send operator to west tower with radiation monitor to:

NOTE: Communicate by intercom, since the stack monitor is affected by portable radio RF.

- a. Verify radiation background at stack monitor.
  - b. Verify control room readings.
  - c. Mark initial needle position on analog display with time for future analysis if control room display becomes inaccessible.
  - d. Verify flow rate through monitor to  $5 \pm 1$  SCFM. If not, use Worksheet A to determine stack monitor values.
6. Pull stack monitor filters and analyze.
7. After determining radionuclide responsible and verifying concentrations greater than **100,000 AEC\*** (a) secure EF-13 and EF-14; (b) secure RF2, SF2, RF1, SF1; (c) secure all individual vent fans. ]
8. The Emergency Coordinator shall evaluate the need for a partial or total evacuation of the facility.

NOTE: For facility evacuations or northeast quadrant evacuation, have sample counting instrumentation removed to RPDB. (Ge-Li detector and dewar; High Resolution Gamma Ray Spectrometer)

9. The Emergency Coordinator shall appoint and have a surveillance team check areas evacuated clear of personnel within 30 minutes.

NOTE: Emergency Director approval required for any voluntary radiation exposure in excess of 10CFR20 limits. (Up to 75 rem for lifesaving, up to 25 rem to prevent exposure to members of general public in excess of 1 rem whole body and 5 rem thyroid.)

10. Determine the need for EMERGENCY SUPPORT ORGANIZATIONS and, if needed, activate them or place them on standby. See TABLE III, EMERGENCY SUPPORT ORGANIZATIONS.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

CORRECTIVE ACTIONS:

1. If the facility was evacuated in Step 8 of IMMEDIATE ACTIONS, continue. IF NOT, go to step 2.
  - a. Commence external surveys of the reactor laboratory building to detect leakage of airborne radioactivity and locate the source radioactivity.
  - b. Commence air sampling at 400 meters downwind of facility as per EMERGENCY AIR SAMPLING PROCEDURE (SEP-6).
  - c. Evaluate results of surveys to determine possible reentry to parts of facility for further investigation, if necessary.
  - d. IF leakage concentrations exceed 100,000 AEC\* averaged over, 24 hours the Emergency Director should consider evacuation of USDA, Science Instrument Shop, Dalton Research Center, and Blood Bank, as per SITE AREA EVACUATION PROCEDURE (SEP-5). ]

IF NOT, Emergency Director should evaluate de-escalating to UNUSUAL EVENT classification.

2. Determine source of airborne radioactivity and try to reduce or eliminate the source.
  - a. REACTOR
    - (1) Check fission product monitor.
    - (2) Check room 114 ARMS.
    - (3) Check pool for gas releases.
    - (4) Check dose rate on room 114 filter bank.

Actions to Consider:

- (1) Sample primary
- (2) Procedure REP-20, High Activity Levels in Primary
- (3) Reactor Isolation (FEP-2)
- (4) Area Evacuations
- (5) Portab's air monitor in room 114

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

SUBSEQUENT ACTIONS:

1. Evaluate results of corrections and subsequent actions to determine need to escalate/de-escalate the emergency classification.
2. Keep record of actions and evaluations for documentation. Use procedures and worksheets.
3. Notify NRC, **Headquarters Operations Officer, Washington, DC** ]  
[301-951-0550] that **an** ALERT condition has occurred within one hour ]  
after event is classified or reclassified. (Use Worksheet C)
4. Notify American Nuclear Insurers (ANI) [203-561-3433] that **an** ALERT ]  
condition has occurred. (Use information in Worksheet C)
5. Notify State Emergency Management Agency (SEMA) [314-751-2748] that  
an ALERT condition has occurred. (Use information in Worksheet C)

RECOVERY ACTIONS:

1. Evaluate potential radiological effects to on-site and off-site personnel before returning access to specific areas effected by ALERT emergency.
2. Procedures shall be written and approved for handling significant recovery evolutions.

NOTE: During recovery operations, personnel exposures to radiation should be maintained within 10CFR20 limits.

SEP-4  
SITE AREA EMERGENCY PROCEDURE

ACTIONS LEVELS:

IF there is:

- a. Concentration of airborne radioactivity at the stack monitor exceeding **500,000 AEC\*** when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).] ]

NOTE: Use **overlays** to determine extent of activity for iodine, particulate, **and gas**. ]

- b. The projected concentration of airborne radiological effluent at the distance corresponding to the nearest site boundary exceeding **375 mrem whole body accumulated in 24 hours**. ]

- c. Radiation levels at the distance corresponding to the nearest site boundary of 100 mrem/hr for 1 hour whole body or 500 mrem thyroid dose.

- d. Other plant conditions exist with a level of significance of major fuel damage and conditions that indicate actual or imminent failure of containment integrity and primary system integrity.

THEN a SITE AREA EMERGENCY condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization, as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.
2. Operations shall provide information to the Emergency Director/Emergency Coordinator.
3. Time and date stack monitor charts for reference.
4. Shut down the reactor.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

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**IMMEDIATE ACTIONS:** (Cont'd)

5. Send operator to west tower with radiation monitor to:

NOTE: Communicate by intercom, since the stack monitor is affected by portable radio RF.

- a. Verify radiation background at stack monitor.
  - b. Verify control room readings.
  - c. Mark initial needle position on analog display with time for future analysis if control room display becomes inaccessible.
  - d. Verify flow rate through monitor to  $5 \pm 1$  SCFM. If not, use Worksheet A to determine stack monitor values.
6. Pull stack monitor filters and analyze.
7. After determining radionuclide responsible and verifying concentrations greater than **500,000 AEC\*** (a) secure EF-13 and EF-14; (b) secure RF2, SF2, RF1, SF1; (c) secure all individual vent fans.
8. The Emergency Coordinator shall evaluate the need for a partial or total evacuation of the facility.

NOTE: For facility evacuations or northeast quadrant evacuation, have sample counting instrumentation removed to RPDB. (Ge-Li detector and dewar; High Resolution Gamma Ray Spectrometer)

9. The Emergency Coordinator shall appoint and have a surveillance team check areas evacuated clear of personnel within 30 minutes.

NOTE: Emergency Director approval required for any voluntary radiation exposure in excess of 10CFR20 limits. (Up to 75 rem for lifesaving, up to 25 rem to prevent exposure to members of general public in excess of 1 rem whole body and 5 rem thyroid.)

10. Determine the need for EMERGENCY SUPPORT ORGANIZATIONS and, if needed, activate them or place them on standby. See TABLE IV, EMERGENCY SUPPORT ORGANIZATIONS.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1.

CORRECTIVE ACTIONS:

1. If the facility was evacuated in Step 8 of IMMEDIATE ACTIONS, continue. IF NOT, go to step 2.

a. Commence external surveys of the reactor laboratory building to detect leakage of airborne radioactivity and locate the source radioactivity.

b. Commence air sampling at 400 meters downwind of facility as per EMERGENCY AIR SAMPLING PROCEDURE (SEP-6). ]

c. Evaluate results of surveys to determine possible reentry to parts of facility for further investigation, if necessary.

d. IF leakage concentrations exceed 500,000 AEC\* averaged over 24 hours, the Emergency Director shall commence evacuation of USDA, Science Instrument Shop, Dalton Research Center, and Blood Bank, as per SITE AREA EVACUATION PROCEDURE (SEP-5). ]

IF NOT, Emergency Director should evaluate de-escalating to ALERT classification.

2. Determine source of airborne radioactivity and try to reduce or eliminate the source.

a. REACTOR

(1) Check fission product monitor.

(2) Check room 114 ARMS.

(3) Check pool for gas releases.

Actions to Consider:

(1) Sample primary

(2) Procedure REP-20, High Activity Levels in Primary

(3) Reactor Isolation (FEP-2)

(4) Area Evacuations

(5) Portable air monitor in room 114

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

SUBSEQUENT ACTIONS:

1. Evaluate results of corrections and subsequent actions to determine need to escalate/de-escalate emergency classification.
2. Keep record of actions and evaluations for documentation. Use procedures and worksheets.
3. Notify NRC, **Headquarters Operations Officer, Washington, DC** ]  
[301-951-0550] that a SITE AREA EMERGENCY condition has occurred ]  
within one hour after event is classified or reclassified. (Use Worksheet C)
4. Notify American Nuclear Insurers (ANI) [203-561-3433] that a SITE AREA EMERGENCY condition has occurred. (Use information in Worksheet C)
5. Notify State Emergency Management Agency (SEMA) [314-751-2748] that a SITE AREA EMERGENCY condition has occurred. (Use information in Worksheet C)

RECOVERY ACTIONS:

1. Evaluate potential radiological effects to on-site and off-site personnel before returning access to specific areas effected by the SITE AREA EMERGENCY.
2. Procedures shall be written and approved for handling significant recovery evolutions.

NOTE: During recovery operations, personnel exposures to radiation should be maintained within 10CFR20 limits.

SEP-7PUBLIC INFORMATION PROCEDURE

NOTE: The MU News Bureau shall be activated to handle the release of public information as required in the ALERT or SITE AREA EMERGENCY procedures; whenever off-site emergency assistance is requested via 911; or whenever deemed appropriate by the Emergency Director.

## A. INITIAL RELEASE OF PUBLIC INFORMATION

1. The Emergency Status Report shall be completed and approved by the Emergency Director. **(The Emergency Director may consider having the MURR Information Specialist act as communications link with MU News Bureau.)** ]
- 2a. During normal University office hours, activate the MU News Bureau by calling 882-6211 (**Rhona Williams**) or 882-9144 (**Connie Mitchell**). ]
- 2b. At other times, call the following list of MU News Bureau staff in order until one of the individuals listed is reached (NOT their spouse, children, etc.).
 

|                           |                 |   |
|---------------------------|-----------------|---|
| 1) <b>Rhona Williams</b>  | <b>449-1586</b> | ] |
| 2) <b>Connie Mitchell</b> | <b>442-6166</b> | ] |
3. Read the Emergency Status Report as approved by the Emergency Director to the MU News Bureau staff member and answer any questions concerning definitions, terms, units, etc.
4. Record other questions that the MU News Bureau staff member may have. Enter the name of the MU News Bureau staff member contacted and give the completed report to the Emergency Coordinator to be kept with the records of the emergency.

5. The MU News Bureau staff member contacted should verify a call concerning an emergency at the University of Missouri Research Reactor by calling 882-4211 or 874-4119 and asking to speak to a member of the Facility Emergency Organization (FEO). If the person answering the phone does not know who is in the FEO, then ask for anyone from the Director's Office, Operations, Health Physics/Reactor Chemistry groups. The individuals in these groups are listed below in alphabetical order. After verifying the person's identity by asking for his social security number, the emergency call can be verified.

VERIFICATION LIST FOR MURR EMERGENCIES

| <u>Name</u>          | <u>Soc. Sec. No.</u> | <u>Name</u>            | <u>Soc. Sec. No.</u> |
|----------------------|----------------------|------------------------|----------------------|
| Chuck Anderson       |                      | Walt Meyer             |                      |
| Rex Ayers            |                      | Brenda <b>Montague</b> | ]                    |
| Joe Baskett          |                      | Steve Morris           |                      |
| Rita Bonney          |                      | Paul Muren             |                      |
| Kenneth Beamer       |                      | Phil Neel              |                      |
| Barry Bezenek        |                      | Willy Oldham           |                      |
| <b>Ronita Dinger</b> | ]                    | Dave Peeler            |                      |
| Chester Edwards      |                      | Derek Pickett          |                      |
| John Ernst           |                      | Leslie Powell          |                      |
| Christine Errante    |                      | Bill Reilly            |                      |
| Les Foyto            |                      | <b>Jim Rhyne</b>       | ]                    |
| John Fruits          |                      | Tony Schoone           |                      |
| Greg Gunn            |                      | Jim Schuh              |                      |
| Andrew Hartweg       |                      | Tom Seeger             |                      |
| Robert Hudson        |                      | Andrea Shipp           |                      |
| Rolly Hultsch        |                      | Vickie Spate           |                      |
| Vernon Jones         |                      | Ray Stevens            |                      |
| Mike Kilfoil         |                      | Nolan Tritschler       |                      |
| Ron Kitch            |                      | Robert Walker          |                      |
| Sue Langhorst        |                      | Mike Wallis            |                      |
| Charlie McKibben     |                      | Tim Warner             |                      |

6. MU News Bureau personnel contacted will determine the need for staffing and equipping an emergency information center and will call in the required staff and arrange for necessary facilities.
7. MU News Bureau personnel will inform news media and others of the **public**, as necessary, of the emergency.
8. If possible, a MU News Bureau staff member will be sent on-site to assist the Emergency Director with the release of information.

## PROCEDURE

NOTE: Although it is preferable to perform and document the steps presented below prior to emergency workers receiving the exposure, the situation (e.g., lifesaving measures) may require the Emergency Director to verbally authorize the exposure and ensure completion of documentation when time permits.

1. Ensure that the dose rate in the task area is known or measurable.
2. Ensure that volunteer has assigned film badge.
3. Complete Worksheet E giving careful attention to item C considerations.
4. Assign the volunteer a self-reader pocket chamber or equivalent immediate readout monitor with a range double the anticipated total exposure for the assignment.
5. The Emergency Director or a delegate shall obtain the exposure recorded by the readout device at a frequency that ensures adequate control to prevent exposures in excess of the planned limits for the volunteer.
  - a. The exposure received at each reading shall be recorded on Worksheet E.

## FOLLOW-UP

1. Expedite processing of volunteer's film badge to verify total exposure as indicated by self-reading dosimeters.
2. If individual's dose equivalent exceeds any 10CFR20 limits, they should be examined by a physician to determine the need, extent and nature of medical surveillance or treatment.

## REPORTING REQUIREMENTS

Complete reporting requirements of 10CFR20.2202. ]

EMERGENCY PROCEDURES  
EMERGENCY CALL LIST

| <u>Director's Office</u>            |                   | <u>Facilities Operations</u>    |                   | <u>Emergency Support Organizations</u>          |                       |
|-------------------------------------|-------------------|---------------------------------|-------------------|---|-----------------------|
|                                     | <u>Phone No.</u>  |                                 | <u>Phone No.</u>  |   | <u>Phone No.</u>      |
| J. Rhyne                            | 442-4967          | C. Edwards                      | 443-7529          | <u>UMC Police</u>                               | 882-7201              |
| J. C. McKibben                      | 442-6728          | D. Peeler                       | 816-848-2471      |   |                       |
| <u>Reactor Operations</u>           |                   | K. Beamer                       | 682-5499          | <u>Columbia Fire Department</u>                 | 9-911                 |
|                                     | <u>Phone No.</u>  | R. Kitch                        | 875-0664          |   |                       |
| W. Meyer                            | 442-7675          | C. Kribbs                       | 682-3980          | <u>UM Hospital &amp; Clinics</u>                |                       |
| T. Schoone                          | 443-8862          | T. Seeger                       | 474-3891          | Emergency Services                              | 882-6003              |
| R. Hullsch                          | 442-6653          | J. Baskett                      | 474-2046          | Ambulance                                       | 882-6128 or 9-911     |
| C. Anderson                         | 696-5506          | <b>M. Richardson</b>            | <b>446-1014 ]</b> | Walk-In (Emergency Center)                      | 882-8091              |
| B. Bezeneck                         | 445-5680          | <u>Staff Resource Personnel</u> |                   |   |                       |
| G. Gunn                             | 875-1162          |                                 | <u>Phone No.</u>  |   |                       |
| N. Tritschler                       | 474-9388          | S. Morris                       | 445-4217          | <u>UMC Health Physics (Office)</u>              | 882-7221              |
| L. Foyte                            | 446-0491          | V. Spate                        | 657-9450          | Dr. Phil Lee (Home)                             | 445-5275              |
| J. Fruits                           | 474-0774          | C. Baskett                      | 474-2046          | Jamieson Shotts (Home)                          | 474-2194              |
| A. Hartweg                          | 445-1557          | M. Glascock                     | 443-4172          | David Spate (Home)                              | 657-9450              |
| R. Hudson                           | 445-6769          | B. McCracken                    | 449-7731          |   |                       |
| V. Jones                            | 445-2543          | W. Oladiran                     | 443-5658          | <u>MU News Bureau</u>                           | 882-6211              |
| P. Muren                            | 874-0219          | D. Nickolaus                    | 443-0502          | See Public Information Procedure for other      | 882-6214              |
| P. Neel                             | 442-8693          | G. Ehrhardt                     | 445-3570          | phone numbers (SEP-7).                          | or 882-6217           |
| W. Oldham                           | 474-0987          | A. Ketring                      | 657-9614          |   |                       |
| R. Walker                           | 443-0970          | B. Yeion                        | 445-8147          | <u>State Emergency Management Agency (SEMA)</u> | 314-751-2748          |
| M. Wallis                           | <b>387-4859 ]</b> | M. Kilfoil                      | 449-2524          |   |                       |
| T. Warner                           | 816-882-6740      | S. Gunn                         | 443-2125          | <u>NRC Washington, DC</u>                       | 301-951-0550          |
| <u>Health Physics/Rx. Chemistry</u> |                   | L. Krueger                      | 442-0740          |   |                       |
|                                     | <u>Phone No.</u>  | T. Storvick                     | 445-4038          | <u>NRC Region III</u>                           | <b>708-829-9500 ]</b> |
| S. Langhorst*                       | 442-3534          |                                 |                   | <u>American Nuclear Insurers</u>                | 203-561-3433          |
| R. Stevens                          | 442-2539          |                                 |                   |   |                       |
| J. Ernst                            | 445-5621          |                                 |                   |   |                       |
| J. Schuh                            | 449-0992          |                                 |                   |   |                       |
| R. Ayers                            | <b>445-0340 ]</b> |                                 |                   |   |                       |
| W. D. Pickett                       | 474-0709          |                                 |                   |   |                       |
| A. Shipp                            | 442-4304          |                                 |                   |   |                       |

\*On leave until January 1994.

WORKSHEET C

CONTENTS OF INITIAL/FOLLOWUP EMERGENCY MESSAGES TO

"HEADQUARTERS OPERATIONS OFFICER" ]  
WASHINGTON, D.C. 301-951-0550 ]

1. Provide name, title, telephone number of caller.

2. Location of emergency event.

UNIVERSITY OF MISSOURI RESEARCH REACTOR (LICENSE R-103) ]  
AT COLUMBIA, MISSOURI ]

3. Description of emergency event and emergency class:

NOTIFICATION OF UNUSUAL EVENT, ALERT, or SITE AREA EMERGENCY

Time of event classification \_\_\_\_\_

The cause or initiating event, if known.

4. Date and time event started:

5. Status of reactor: e.g. shutdown, fuel damage.

6. Was there actual release of radioactive material? (estimate quantity)

Has the release been terminated?

7. What protective actions taken? e.g. evacuation of facility, site area evacuation

8. What outside assistance is required? e.g. SEMA, Fire Department, Medical Facilities

9. Are there any injuries? Are the injured contaminated?

10. Estimate impact of release? e.g., is general public expected to be affected?

EMERGENCY DIRECTOR—AUTHORIZATION TO CALL \_\_\_\_\_

## FEP - DESCRIPTION OF RADIATION ALARMS AND PERSONNEL RESPONSE

| System Responsible for Alarm    | Location of Sensors                                   | Audible Location       | Type of Alarm          | Facility Staff<br>Personnel Response                             | Non-Staff<br>Personnel Response                 |
|---------------------------------|---|------------------------|------------------------|--|---|
| 1. Isolation System             | a. Manual Switch in Control Room                      | Throughout Containment | Horn ▲ ●               | Execute FEP-2, Reactor Isolation Procedure                       | Execute FEP-2, Reactor Isolation Procedure ]    |
|                                 | b. Air plenum (ARM) (fifth level) (2)                 |                        |                        |  | ]   |
|                                 | c. Reactor bridge (ARM) (2)                           |                        |                        |  | ]   |
| 2. Evacuation System            | a. Control Room (manual)                              | Throughout Facility    | Horn ▲ ●               | Execute FEP-1, Facility Evacuation Procedure                     | Execute FEP-1, Facility Evacuation Procedure ]  |
|                                 | b. Front Lobby (manual)                               |                        |                        |  | ]   |
| 3. Particulate Monitor          | Portable in Containment                               | Local                  | Bell and red light     | Cause immediate area to be vacated and notify Reactor Operations | Vacate containment; Notify Reactor Operations ] |
| 4. Area Radiation Monitor (ARM) | a. South wall-BP Floor                                | Local; Control Rm      | Buzzer and red light ▲ | Execute REP-4, High Radiation Level Procedure                    | Vacate immediate area ]                         |
|                                 | b. West wall-BP Floor                                 |                        |                        |  | ]   |
|                                 | c. North wall-BP Floor                                |                        |                        |  | ]   |
|                                 | d. Fuel Storage Room                                  |                        |                        |  | ]   |
|                                 | e. Heat Exchanger Room (114)                          |                        |                        |  | ]   |
| 5. Hand and Foot Monitors       | Basement exit (outer corridor)                        | Local                  | Buzzer and Indication  | Notify Health Physics ■  | Notify Health Physics ■                         |
|                                 | West corridor   | Local                  | Buzzer and red light   | Notify Health Physics ■  | Notify Health Physics ■                         |
| 6. Portal Monitor               | East Exit   | Local                  | Alarm and Indication   | Notify Health Physics ■  | Notify Health Physics ■ ]                       |
| ▲                               | Buzzer and red light in Control Room ]                |                        |                        |  |   |
| ●                               | Flashing red light near containment entrance          |                        |                        |  |   |
| †                               | Control Room annunciator buzzer and light             |                        |                        |  |   |
| ■                               | After normal working hours, notify Reactor Operations |                        |                        |  |   |

FEP-1  
FACILITY EVACUATION PROCEDURE

NOTE: An assessment of off-site radiological consequences shall be determined. This assessment may require escalating emergency response to a site emergency procedure (UNUSUAL EVENT, ALERT or SITE AREA EMERGENCY).

ENTRY CONDITIONS:

1. The Facility Evacuation alarm is actuated manually from two locations:
  - a. the reactor control room, and
  - b. the lobby control center.
2. Situations that may warrant FACILITY EVACUATION include:
  - a. Security emergencies, such as a bomb threat.
  - b. A major facility fire.
  - c. Whenever airborne radioactivity is expected to exceed 50 AEC\* throughout the facility.
  - d. This procedure may be used as part of a Site Emergency Procedure (SEP).
  - e. Other conditions occur that the Shift Supervisor determines warrant personnel evacuation from the facility.

AUTOMATIC ACTIONS:

The following events result from a Facility Evacuation alarm:

1. The reactor scrams.
2. The containment ventilation system isolation doors close.
3. The containment exhaust isolation valves close.
4. The facility horns sound.
5. The flashing red light exterior to the containment personnel airlock door is energized.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1.

FEP-2  
REACTOR ISOLATION

NOTE: An assessment of off-site radiological consequences shall be determined. This assessment may require escalating emergency response to a site emergency procedure (UNUSUAL EVENT, ALERT or SITE AREA EMERGENCY).

ENTRY CONDITIONS:

1. A REACTOR ISOLATION is automatically initiated by either of two radiation monitors in the containment air exhaust plenum or a radiation monitor on the reactor bridge. They are activated at levels greater than 1 decade above background.
2. A REACTOR ISOLATION may be activated manually at the reactor control console.
3. Shutdowns that may warrant REACTOR ISOLATION include:
  - a. A prolonged fire within containment.
  - b. Whenever airborne radioactivity levels are expected to exceed **50 AEC\*** ] in containment.
  - c. This procedure may be used as part of a Site Emergency Procedure (SEP).
  - d. Other conditions occur that the Shift Supervisor determines warrant personnel evacuation of containment.

AUTOMATIC ACTIONS:

The following events result from a Reactor Isolation alarm:

1. The reactor scrams.
2. The containment ventilation system isolation doors close.
3. The containment exhaust isolation valves close.
4. The containment horns sound.
5. The flashing red light exterior to the containment personnel airlock door is energized.

\*AEC-Air Effluent Concentration as per 10CFR20, Appendix B, Table 2, Column 1. ]

FEP-3(a)

CONTROL ROOM RESPONSE TO ALPHA LABORATORY FIRE

NOTE: Throughout this procedure continue to monitor stack exhaust monitor, Alpha Laboratory exhaust monitor (alpha-6) or Alpha Laboratory room monitor (alpha-3) for indication of airborne radioactivity, as appropriate.

1. If a fire is detected by fire alarm or reported in the Alpha Laboratory, the shift supervisor (or senior licensed person in control) will verify and call the Columbia Fire Department.
2. The shift supervisor will activate the Facility Emergency Organization by page system (or after hours by Emergency Call List) and provide warning to stay clear of facility basement.
3. The Emergency Director will determine nature and specific location of fire (i.e., if fire is in glove box or equipment exterior to glove box).
4. If fire cannot be put out immediately with local fire extinguishers, the reactor will be shut down to focus attention on the fire.
5. Ensure Alpha Laboratory doors are shut and personnel are out of the laboratory. If no experimenter is present, call the on-call experimenter as soon as time permits.
6. If there is a likelihood of the fire spreading through the ventilation system, secure EF-13 and EF-14 at breaker on the emergency distribution center (in north inner corridor).
7. Secure electrical power to Alpha Laboratory at following locations:
  - a. Breaker #13 on UPS #2 - in control room (this secures power to the argon glove box and deactivates the glove box exhaust valves in their current position).
  - b. Breaker #17 on 120/208 V distribution center - in north inner corridor (this secures power to LP-34 which will secure lights and receptacles).
  - c. Breaker #2 on emergency power panel - in north inner corridor (this secures power to ELP #2 outside Alpha Laboratory, which will secure Alpha Laboratory supply and exhaust fans).

8. Secure ventilation supply fan SF-1, north RTAH, south RTAH, at MCC-3 and check closed all fire doors.
9. Isolate Alpha Laboratory by closing supply damper (above vial cleaning hot cell), and exhaust damper (overheat, after last exhaust filter bank), if possible.
10. The Emergency Director (or his delegate) should contact Fire Department outside of facility to provide specific information.
11. The Emergency Director will stay in contact with Incident Commander to coordinate fire fighting and life saving efforts.
12. Contact MU News Bureau to handle release of public information (SEP-7). ]

HEALTH PHYSICS STANDARD OPERATING PROCEDURES  
(New manual issued 10/29/90)

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## Calibration of Sample Counting Systems

### I. Policy

Sample data that has a direct effect on radiation risk evaluation shall be counted with a calibrated instrument.

### II. Purpose

The purpose of this procedure is to establish a standard method for the calibration of the following counting systems:

- A. Canberra Model 2400 Alpha/Beta/Gamma System.
- B. Baird Polyspec Research Spectrometer.
- C. Eberline Model BC-4 Beta Counter.
- D. Baird Polyspec Research Spectrometer - Computer Controlled. ]
- E. Tennelec LB-5100 Alpha/Beta. ]

### III. Procedure -- Canberra 2400 Alpha/Beta/Gamma System ]

- A. Determining the operating voltage:
  - 1. Use Pu-239 calibration source for alpha counting only.
  - 2. Use SrY-90 calibration source for beta and simultaneous alpha/beta counting.
  - 3. Place proper calibration source in planchet and load into elevator magazine.
  - 4. Press [ADVANCE] [ADVANCE].
  - 5. Press [PLATEAU].
  - 6. Choose a time increment that will yield approximately 10,000 counts in the plateau.
  - 7. Set discriminator window to 0, press [ENTER].

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8. With printer on line, a graph of the plateau curve will automatically print. Choose an operating voltage 50 volts above the knee of the curve.

NOTE: For simultaneous alpha/beta counting, III.B. and III.C. must be completed. For alpha or beta only, go to step III.D.

B. Determining window setting:

1. Place beta calibration source in planchet and load into elevator magazine.
2. Press [ADVANCE] [ADVANCE].
3. Press [WINDOW].
4. Select operating voltage determined in III.A.8. above, press [ENTER].
5. A graph of DISC vs COUNTS will automatically print. Choose the DISC setting where counts go to zero.
6. Optimum window setting is where 0.5-1.0% of beta counts are detected in the alpha channel. To check the window setting, use the following steps:
  - a. Place beta calibration source in planchet and load into elevator magazine.
  - b. Press [ADVANCE] [ADVANCE].
  - c. Edit program 0 in the following manner: (after selecting parameter press [ENTER], if parameter is correct as shown just press [ENTER]).

Press [EDIT] [0] [ENTER]

PRESET COUNT: [999999]

PSET TIME: [1.00]

HIGH VOLTAGE: Select voltage determined in III.A.8.

DISC WINDOW: Select setting determined in III.B.5.

CHI-SQUARE (0=N,1=Y): [0]

ERROR (SIGMA): [1.96]

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REPEAT #: [0]  
A EFFIC (%): [0]  
A CROSTLK (%): [0]  
A BKGND (CPM): [0]  
B EFFIC (%): [0]  
B BKGND (CPM): [0]  
BKGD TIME (M): [0]  
VOL UNITS: [0]  
VOL (EA): [1.00]  
ACTIVITY UNITS: [1]  
ALARM (dpm/V): [200.0]

- d. When editing is complete press [RUN] [0] [ENTER] [COUNT].
- e. Gross alpha and beta counts will print. Divide gross alpha counts into gross beta counts. If the result is 0.5-1.0% the DISC WINDOW is correct.
- f. If it is not, go back to III.B.6.c., add 50 to the current DISC WINDOW setting, and repeat steps d. and e. If the result still does not meet the recommendations, repeat steps c., d., and e., adding 50 to the DISC WINDOW each time until 0.5-1.0% of the beta counts fall into the alpha channel.

C. Measure alpha crosstalk:

1. Place alpha calibration source in planchet and load into elevator magazine.
2. Press [ADVANCE] [ADVANCE].
3. Edit program 0 using method described in III.B.6.c. Enter values for high voltage and disc window determined in steps III.A. and III.B. above.
4. Press [RUN] [0] [ENTER] [COUNT].
5. Gross alpha and beta counts will print. Alpha crosstalk is calculated using the following equation:

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Crosstalk = beta counts/(alpha counts+beta counts)

D. Chi-square test:

1. Use a combination alpha/beta calibration source or repeat these steps with an alpha and/or a beta calibration source as needed.
2. Place calibration source in planchet and load into elevator magazine.
3. Press [ADVANCE] [ADVANCE].
4. Edit program 0 inserting the values determined in steps III.A.-III.C., including the following additional changes to the parameters set in III.B.6.c.:

```
CHI-SQUARE (0=N,1=Y): [1]
REPEAT #: [20]
```

5. Press [RUN] [0] [ENTER] [COUNT].
6. The system will count the source 21 times. After the last count, the chi-square value will print. For 20 degrees of freedom, a chi-square value between 11 and 27 is satisfactory.
7. If the chi-square value is not satisfactory, repeat section III.A. If the operating voltage has changed, repeat all parts of section III using the new high voltage value. If the operating voltage is the same as determined before, repeat the steps in III.D. Should the results still be unsatisfactory, contact the Health Physics group, and do not use the instrument for sample counting.

E. Determining efficiencies:

1. Place alpha and beta calibration sources in separate planchets. Load the sources, one empty planchet to determine background, and the aluminum end disc into the elevator magazine.
2. Edit a program (normally program 5) in the

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following manner: (after selecting parameter press [ENTER], if parameter is correct as shown just press [ENTER])

Press [EDIT] [program #] [ENTER]

PRESET COUNT: [999999]

PSET TIME: Select desired count time in minutes,  
(normally 5 minutes)

HIGH VOLTAGE: Select voltage determined in III.A.8.

DISC WINDOW: Select disc window determined in III.B.

START SAMPLE: [0]

STOP SAMPLE: [99]

ERROR (SIGMA): [1.96]

REPEAT #: [0]

A EFFIC (%): [0]

A CROSTLK (%): Select value determined in III.C.

A BKGND (CPM): [0]

B EFFIC (%): [0]

B BKGND (CPM): [0]

BKGD TIME (M): [0]

VOL UNITS: [0]

VOL (EA): [1]

ACTIVITY UNITS: [1]

ALARM (dpm/V): [200]

3. When editing is complete press [RUN] [program #]  
[ENTER] [RESTACK].

4. Efficiencies are calculated from the following  
equation:

$$\text{Efficiency} = (\text{Gross counts} - \text{bkgd}) / 4 \text{ Pi Source dpm}$$

5. If efficiency differs from the previous value by  
greater than 10%, contact the Health Physics group.  
Previous values can be found in the instrument log  
book.

#### F. Editing counting program:

1. Choose counting program to be edited. Program 1 is reserved for normal swipe counting, program 2-5 are available for other sample counting procedures. Enter parameters in the following manner: (after

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selecting parameter press [ENTER], if parameter is correct as shown just press [ENTER])

Press [EDIT] [program #] [ENTER]

PRESET COUNT: [999999]  
PSET TIME: Select desired count time in minutes  
HIGH VOLTAGE: Select voltage determined in III.A.8.  
DISC WINDOW: Select disc window determined in III.B.  
START SAMPLE: [0]  
STOP SAMPLE: [99]  
ERROR (SIGMA): [1.96]  
REPEAT #: [0]  
A EFFIC (%): Select value determined in III.E.  
A CROSSTLK (%): Select value determined in III.C.  
A BKGND (CPM): Select value determined in III.E.  
B EFFIC (%): Select value determined in III.E.  
B BKGND (CPM): Select value determined in III.E.  
BKGND (M): Select time used in III.E.  
VOL UNITS: [0]  
VOL (EA): [1]  
ACTIVITY UNITS: [1]  
ALARM (dpm/V): [200]

G. See HP SOP 33 for sample counting instructions.

#### IV. Procedure -- Baird Polyspec Research Spectrometer

A. Determine plateau:

1. Switch power to off.
2. Adjust switches to following positions:
  - a. Scaler
    1. Preset count/bs -- bs.
    2. Background subtract -- all zeros.
  - b. Analyzer
    1. Diff./integr. -- integr.
    2. Lower 1. -- 7.

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- c. Amplifier
    - 1. Coarse gain -- 1/32.
    - 2. Fine gain -- 0.45.
  - d. Display
    - 1. Set to scal. 1.
  - e. Timer:
    - 1. Set switch to timer.
    - 2. Time base -- 0.1 sec.
    - 3. Preset time -- 10.
  - f. Control:
    - 1. Manual/Automatic -- Manual.
    - 2. Off/drm -- drm.
  - g. High voltage:
    - 1. Course H.V. -- 1.6 (Switch on back panel. Caution: any change of this switch should be made while high voltage is in standby.)
    - 2. Fine H.V. -- midrange.
    - 3. On/Standby -- Standby.
- 3. Switch power on.
  - 4. Switch on/standby to on.
  - 5. Place calibration source under detector: Pu-239 for alpha counting or SrY-90 for beta or alpha+beta counting.
  - 6. Press the start button.

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7. Increase high voltage stepwise until scaler shows a count rate.
8. Decrease high voltage one step.
9. Press stop button.
10. Switch off/drm to off.
11. Set time base to 0.1 minute.
12. Press start button. Take one minute counts, increasing the high voltage 100 volts after each count, until a plateau is reached and counts begin to increase again. Plot a curve of high voltage vs counts per minute. ]
13. Proper high voltage setting is approximately the middle of the plateau. Record value in instrument log book.

B. Scaler test function:

1. Adjust switches as described in IV.A.2. with the modifications in IV.A.10. and IV.A.11.
2. Press start.
3. After one minute scaler reading should be approximately 7200. Record value in instrument log book.

C. Chi-square test:

1. Switch printer to on.
2. Place calibration source in planchet. Load planchet on left planchet stand and press start. When source is under detector switch planchet changer to off.
3. Adjust switches as described in IV.A.2. with the modifications in IV.A.10. and IV.A.11.
4. Press the start button, allow calibration source to

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count 21 times then press stop button.

5. The chi-square is calculated from the following equation:

$$\chi^2 = \frac{\sum (a_i - A)^2}{n A}$$

Where:

- A = average counting rate
- a = counting rate observed in any counting interval
- n = number of observations
- $\chi^2$  = Chi-square value

6. For 20 degrees of freedom, a chi-square value between 11 and 27 is satisfactory. If the chi-square value is not satisfactory, contact the Health Physics group.

D. Determining efficiencies:

1. Adjust switches as described in IV.A.2. with the following modifications:
  - a. Timer
    1. Time base -- 0.1 minute.
    2. Preset time -- 50.
  - b. Control
    1. Manual/Automatic -- Automatic.
    2. Off/drm -- off.
  - c. High voltage
    1. Set value determined in IV.A.

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2. Set up automatic planchet changer as follows:

Single/Recycle -- single.

- b. Power switch -- on.

3. Place alpha and beta calibration sources in separate planchets. One the left planchet stand, load the sources, and an empty planchet to determine background.
4. Press start button on planchet changer.
5. Efficiencies are calculated from the following equation:  
  
Efficiency = (Gross counts-Bkgd)/4 Pi Source dpm  
  
Record value in instrument log.
6. If efficiency differs from the previous value by greater than 10%, contact the Health Physics group. Previous values can be found in the instrument log book.

E. See HP SOP 33 for sample counting instructions.

V. Procedure -- Eberline BC-4 Beta Counter

A. Chi-square test:

1. Load beta calibration source in planchet and close drawer.
2. Set count time to 1 minute.
3. Count source 21 times, record values.
4. The chi-square is calculated from the following equation:

$$\chi^2 = \frac{\sum (a_i - A)^2}{n A}$$

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Where:

- A = average counting rate
- a = counting rate observed in any counting interval
- n = number of observations
- $\chi^2$  = Chi-square value

5. For 20 degrees of freedom, a chi-square value between 11 and 27 is satisfactory. If the chi-square value is not satisfactory, contact the Health Physics group.

B. Determining efficiency:

1. Load beta calibration source in planchet and close drawer.
2. Set count time to 5 minutes.
3. Press start. After count is complete record value in instrument log book in counts per minute.
4. Remove calibration source, close drawer and count background for 5 minutes. Record value in instrument log book in counts per minute.
5. Efficiency is calculated from the following equation:

$$\text{Efficiency} = (\text{Gross counts} - \text{bkgd}) / 4 \text{ Pi source dpm}$$

Record value in instrument log book.

6. If efficiency differs from previous value by greater than 10% contact Health Physics group.

VI. Procedure -- Baird Polyspec - Computer Controlled ]

A. Determine plateau: ]

1. Switch power to off. ]

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2. Adjust switches to the following positions: ]
- a. Scaler ]
  1. Preset count/bs -- bs. ]
  2. Background subtract -- all zeros. ]
- b. Analyzer ]
  1. Diff./integr. -- integr. ]
  2. Lower 1. -- 7. ]
- c. Amplifier ]
  1. Coarse gain -- 1/32. ]
  2. Fine gain -- 0.45. ]
- d. Display ]
  1. Set to scal. 1. ]
- e. Timer ]
  1. Set switch to timer. ]
  2. Time base -- 0.1 sec. ]
  3. Preset time -- 10. ]
- f. Control ]
  1. Manual/Automatic -- Manual. ]
  2. Off/drm -- drm. ]
- g. High Voltage ]
  1. Coarse H.V. -- 1.6 (Switch on back panel. ]  
Caution: any change of this switch must be ]  
made while the high voltage is in ]  
standby.) ]

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2. Fine H.V. -- midrange. ]
  3. On/Standby -- Standby. ]
  3. Switch power to on. ]
  4. Switch on/standby to on. ]
  5. Place calibration source under detector: Pu-239 for alpha counting or SrY-90 for beta or alpha+beta counting. ]
  6. Press the start button. ]
  7. Increase high voltage stepwise until scaler shows a count rate. ]
  8. Decrease high voltage one step. ]
  9. Press stop button. ]
  10. Switch off/drm to off. ]
  11. Set time base to 0.1 minute. ]
  12. Press start button. Perform one minute counts increasing the high voltage 100 volts after each count until a plateau is reached and counts begin to increase again. Plot a curve of high voltage vs counts per minute. ]
  13. Adjust the high voltage to be about 50 volts above the knee of the curve plotted in 12 above. Record this value in the instrument log book. ]
- B. Scaler test function: ]
1. Adjust switches as described in A.2. with the modifications in A.10. and A.11. ]
  2. Press start. ]
  3. After one minute, scaler reading should be ]

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approximately 7200. Record value in the instrument log book. ]

C. Computer System Start-up: ]

1. Place the computer power switch to the on position. The computer will go through its start-up routine. ]
2. At the DOS prompt type "DATE". Type the date MM-DD-YY and hit enter. ]
3. Type "TIME". Type the time 00:00 and hit enter. ]
4. At the DOS prompt type "SWIPE". This will initiate the swipe counting program and arrive at the main menu. ]

D. Chi-square test: ]

1. Place a SrY-90 source in the planchet. ]
2. From the main menu screen press "4" then hit enter. ]
3. It will ask you to enter the count time per trial in seconds. Type 60 then hit enter. ]
4. It will then prompt you to enter the number of trials. Type 21 and hit enter. ]
5. The system will now automatically perform the chi-square test. Once the test is completed the chi-square value will be displayed on the screen. Press shift and print screen button to obtain a printout of this value. A normalized chi-square value of 0.6 to 1.6 is necessary. If the value is repeatedly outside of this range, tag the equipment for repair. ]

E. Determining efficiencies: ]

1. From the main menu type 2 to determine background. It will prompt you for the count time. Type 300 and hit enter. ]

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2. After background is completed enter the counts per minute value in the instrument log book. ]
3. Place a SrY-90 source in the planchet. ]
4. Hit enter once to return to main menu. Type 3 to determine efficiency. It will prompt you to enter count time in seconds. Type 300 and hit enter. ]
5. The system will then count the source for the 300 seconds. When the count is finished it will prompt you to enter the source activity in dpm. Type the activity for the most recent calibration of the source being used and hit enter. ]
6. The computer will automatically calculate the efficiency based on this activity. Record this efficiency value in the instrument log book. ]
7. To determine alpha efficiency, place the alpha source in the planchet. Press start on the sample changer. Wait for the sample changer to stop. ]
8. Set timer to preset time to 50. Press the start button. ]
9. After the 5 minute count, record the value in counts per minute in the log book. ]
10. Calculate the efficiency by taking (cpm-bkg)/source dpm. Record this value in the log book. ]
11. If the efficiency value differs from the previous value by greater than 10%, contact the Health Physics group. Previous values can be found in the instrument log book. ]

F. See HP SOP 33 for sample counting instructions. ]

VII. Procedure -- Tennelec LB-5100 Alpha/Beta ]

Note: For any of the following steps, the key must be used in the control panel to place the panel in the PROGRAM position. Also, it is assumed that the unit has no samples on it and you have removed the Group A sample carrier. ]

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- A. Determining the operating voltage. ]
1. Use Pu-239 calibration source for alpha counting only. ]
  2. Use SrY-90 calibration source for beta counting only. ]
  3. Place Group D planchet in the elevator magazine. ]
  4. Place the proper calibration source in an empty sample planchet and load into elevator magazine. ]
  5. Place the end planchet on top of the source planchet in the elevator magazine. ]
  6. Verify the switch and dial settings on the TC 264A as follows: ]  
Gain----64 Line Noise      Discr.----Fully CCW ]
  7. Verify the switch and dial settings on the TC 265A as follows: ]  
Gain----16                      Alpha Discr.----Fully CW ]  
A+B Discr----Fully CCW ]
  8. Press "Q" on the keyboard. This will initiate the plateau program. ]
  9. Enter 1 for the number of samples. ]
  10. Enter D for the group letter to be used. Ensure that group D is set up to yield approximately 10,000 counts in the plateau. (5.4 minutes for 5460 dpm source) ]
  11. Enter the starting voltage: 900 for beta 420 for alpha. ]
  12. Enter the ending voltage: 1800 for beta and 1080 for alpha. ]
  13. Enter the step voltage: 30 volts for either alpha or beta. ]

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14. The system will now automatically perform the plateau and print the results. The results need to be graphed so that the knee of the curve can be determined. The correct operating voltage is 50 volts above the knee of the curve. ]
  15. To edit the high voltage, press V from the main menu. ]
  16. Enter the new alpha high voltage and press enter. ]
  17. Enter the new beta high voltage and press enter. ]
  18. Press enter once again to complete editing. ]
- B. Setting the Alpha Discriminator: ]
1. Place the SrY-90 source in position under the detector and perform a count. Reduce the Alpha Discriminator on the TC 265A until 1% of the gross beta counts are occurring in the alpha channel. ]
  2. Perform ten one minute counts of the alpha source and average the results. The crosstalk should be less than 9% for Pu-239. ]
- C. Chi-squared test: ]
1. Use a combination alpha/beta calibration source or repeat these steps with an alpha and/or a beta calibration source as needed. ]
  2. Place the Group B planchet into the elevator magazine. ]
  3. Place the proper calibration source into a planchet and place into the elevator magazine followed by the END planchet. ]
  4. Press B to begin. ]
  5. It will ask you whether to use the first sample as background. Enter N for no. ]

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6. It will then ask you whether to print chi-square or not. Enter Y for yes. ]
7. The system will now perform a chi-squared test and print the results for 21 sample counts, one minute each. The print out will give you three numbers at the end of the last count. The first one is for alpha, the second is for beta, and the third one should be disregarded. ]
8. For the system to be operating properly the chi-squared values for both alpha and beta should fall between 11 and 27. If the value of the chi-squared repeatedly falls outside of this region, contact Health Physics and tag the unit as OOC and do not use this unit for any sample assay. ]

D. Determining efficiencies: ]

1. Use alpha calibration source for alpha efficiency determination. ]
2. Use SrY-90 calibration source for beta efficiency determination. ]
3. Place the Group C planchet in the elevator magazine. ]
4. Place the alpha calibration source in a planchet and place into elevator magazine followed by the beta calibration source followed by the background planchet and finally the END planchet. ]
5. Press ADVANCE on the control panel. ]
6. The system will now automatically count each sample 5 minutes for determining efficiencies. ]
7. Efficiencies are calculated from the following equation: ]  
Efficiency = (Gross cpm-bkgd cpm)/4 Pi Source dpm ]



## MURR SHIPPING PROCEDURES

| <u>Procedure</u> | <u>Date Issued</u> |
|------------------|--------------------|
| MURR-SAS-00000   | 4/13/93            |
| MURR-SAS-00002   | 4/15/93            |
| MURR-SAS-00003   | 4/15/93            |
| MURR-SAS-00004   | 2/17/93            |
| MURR-SAS-00005   | 5/17/93            |

Procedure Cover Sheet

MURR-SAS-00000  
(Procedure)

0  
(Revision)

13 April 1993  
(Date)

Service Applications Departmental Administrative: Shipping  
(Procedure Title)

Prepared By *U. W. Zeger*  
(Signature)

Reviewed By *Ann R. ...*  
(Signature)

Revision Summary

| <u>Rev. #</u> | <u>Date</u> | <u>Significant</u> | <u>Summary</u> |
|---------------|-------------|--------------------|----------------|
| 0             | 13 April 93 | Yes                | Original       |

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SERVICE APPLICATIONS DEPARTMENTAL ADMINISTRATIVE:  
SHIPPING

1.0 PURPOSE AND SCOPE

The purpose of this Procedure is to delineate the responsibilities and to establish policies for radioactive material shipments entering or leaving the Service Applications Department, Shipping, Missouri University Research Reactor (MURR).

To ensure Compliance with applicable Regulations of Code of Federal Regulations (CFR), 10CFR, 49CFR, and International Air Transport Association (IATA).

Service Applications Department, Shipping's principal objective is to ship without error.

- 1.1 This Procedure applies to all permanent, part-time or student personnel associated with Service Applications Department, Shipping.
- 1.2 All personnel assigned to Service Applications Department, Shipping, must abide by all associated Procedures, to include:
  - 1.2.1 MURR-SAS-00000: Service Applications Departmental Administrative, Shipping.
  - 1.2.2 MURR-SAS-00001: Not assigned, to be developed later.
  - 1.2.3 MURR-SAS-00002: Hot Cell Preparation of Radioactive Material for Shipment.
  - 1.2.4 MURR-SAS-00003: Hot Laboratory Preparation of Radioactive Material for Shipment.
  - 1.2.5 MURR-SAS-00004: Shipment of Radioactive Materials.
  - 1.2.6 MURR-SAS-00005: Reload Radioactive Material.

2.0 PRECAUTIONS AND LIMITATIONS

- 2.1 The non-fixed contamination on any external surface of the transfer cask, work tables or, tools must be kept as low as practical.
- 2.1.1 The level of non-fixed radioactive contamination may be determined by wiping an area of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.
- 2.2 Ensure that all beta-gamma dose rate survey, contamination counting, and gamma radioisotope equipment calibration stickers have not passed the calibration due date prior to use.
- 2.3 Ensure that upon leaving the hot cell or hot laboratory area you measure for personal external contamination by use of Hand-foot monitors or equivalent device.
- 2.3.1 When the Hand-foot monitor alarms indicating external contamination, call Health Physics immediately at extension # 882-5217.
- 2.3.2 After 5:00 P.M. or Weekends call the Control Room at extension # 882-5213.
- 2.4 Maintain radiation exposure As Low As Reasonably Achievable (ALARA) by use of Time, Distance, and Shielding, e.g:
- Do not ride down the elevator with the cask containing the samples removed from the Reactor pool.
- 2.5 Ensure that the transfer cask used to transfer the samples from the Reactor pool to the hot cell is wiped and bagged to prevent contamination during its movement.
- 2.5.1 Examine poly bag for holes or tears.
- 2.5.2 Use Extreme Caution when removing the bag from the cask prior to placing the cask into the hot cell to prevent spread of contamination.
- 2.5.3 Use Extreme Caution when placing the bag on the cask prior to moving the cask to a storage area to prevent spread of contamination.

- 2.6 Use protective clothing:
- Laboratory Coat
  - Rubber/Latex Gloves
  - Breathing Mask: Type to minimize ingestion/inhalation of particulate matter.
  - Safety Glasses or Face Shield.
- 2.7 In the event of a broken vial or stuck sample, the Reactor Services Engineer or Designee must be notified immediately to resolve the problem.
- 2.8 A package of radioactive material shall not be transported unless it is properly described, classed, marked, packaged and labeled.
- 2.9 If the Radioactive Material exceeds any of the applicable limits of 49CFR or IATA Manual, the Reactor Services Engineer or Designee must be notified immediately.
- 2.9.1 The Radioactive Material shall not leave MURR until the problem has been resolved.

3.0 DEFINITIONS

- 3.1 Activity: Is a measure of the quantity of radioactivity emitted by a radioisotope and is used to determine the amount of radioactive material which may be transported in various types of packaging.
- 3.2 Hot Cell: A sealed, shielded controlled area to process radioactive materials containing:
- Manipulators to process radioactive materials.
  - A crane to move heavy objects.
  - A radioactive waste storage area.
  - Negative air pressure which exhausts to the Reactor Air Plenum.
  - A drain for liquid hot waste.
  - Can opener.
  - A welding unit.
- 3.3 Hot Laboratory: A controlled area to process radioactive materials containing a hood which exhausts to the Reactor Air exhausts and a drain for liquids to hot waste.

- 3.4 Observer: An Independent Verifier who observes critical points of the processing steps and documents the performance of these steps by legibly initialing the steps as they are performed.
- 3.5 Performer: The individual who performs the critical step of the process and documents the performance of these steps by legibly initialing the steps as they are performed.
- 3.6 Radioactive Contents: The radioactive material together with any contaminated solids, liquids and gases within the package.
- 3.7 Radioactive material: Any material having a specific activity greater than 70 KBq/kg (0.002 uCi/g).
- 3.8 Shall, Must, Should:
- 3.8.1 Shall: Regulatory Commitment to Code of Regulations, 10CFR, 49CFR and IATA Dangerous Goods Regulations.
- 3.8.2 Must: MURR Internal Commitment to 10CFR, 49CFR and IATA Regulations.
- 3.8.3 Should: Should be accomplished; not required.
- 3.9 Transfer Cask: Used to transport samples within the facility.
- 3.9.1 Orange Roll Up cask is included as a transfer cask.
- 4.0 RESPONSIBILITIES
- 4.1 Reactor Services Engineer: As Manager of the Service Applications Group, Shipping, is responsible for the overall administration of the Shipping Department.
- Ensures that all Post-Irradiation handling of in-pool samples and all radioactive material shipments are performed in accordance with Approved Procedures meeting all applicable Regulations by:
- 4.1.2 Review and Approval of Shipping Procedures.
- 4.1.3 Ensuring Compliance with Shipping Procedures.
- 4.1.4 Ensuring training is conducted for Shipping Personnel on Shipping Procedures.
- 4.1.5 Ensuring maintenance of training records of Shipping Personnel.

- 4.2 Service Applications Section Leader- Shipping: As Supervisor of the Service Applications Group Shipping, is responsible for the overall supervision of the Shipping Department personnel.

To ensure that all Post-irradiation handling of in-pool samples and all radioactive material shipments are performed in accordance with Approved Procedures meeting all applicable Regulations by:

- 4.2.1 Review of Shipping Procedures.
- 4.2.2 Scheduling and implemetation of training of Shipping Procedures.
- 4.2.3 Identifying initial training and retraining.
- 4.2.4 Maintaining Documented training records.
- 4.3 Shipping Technician (Shipper): Defined to be any person in the Shipping Group.
- 4.4 Shipper, Certified: Is Qualified to perform the tasks required in all aspects of shipping as Documented by Training and is Qualified to sign Certifications for MURR.
- 4.5 Shipper, Qualified: An individual who has completed the Required Documented Training to perform specific Tasks.
- 4.6 Shipper, Trainee: Can neither Perform or Inspect a Task.
- 4.7 Health Physics Manager: Is responsible for the overall administration of the Health Physics Group and to provide Health Physics support as required to the Service Applications Group, Shipping, in preparation of radioactive shipments by:
- 4.7.1 Survey of recieved radioactive material.
- 4.7.2 Supervising opening of packages containing radioactive material.
- 4.7.3 Review and Approval of Radioactive Material Shipping Procedures.
- 4.7.4 Maintaining radiological control of the shipping process.

- 5.0 PROCEDURE
- 5.1 Ensure that Consignees (Receivers) for MURR Shipments of radioactive materials are properly authorized to receive the Type, Form, and Quantity of such material in accordance with Provisions of 10CFR.
- 5.2 The following unique characteristics of each shipment shall be maintained throughout Receipt, Safety Analysis, Preparation for Irradiation, Irradiation, Post Irradiation Processing, Packaging, and Documentation:
- 5.2.1 Material Description,
- 5.2.2 Amount (Mass),
- 5.2.3 Isotopes,
- 5.2.4 Activity,
- 5.2.5 Destination,
- 5.2.6 Recipient's License Number, Amendment Number and Expiration Date or certificate in accordance with 10CFR.
- 5.2.7 MURR Identification Number.
- 5.3 Data integrity must be maintained by Documented Control Sheets of the Performer's action with an Observer Verification at critical points in the process.
- 5.3.1 The "Performer" of a shipping process and "Observer" must not be the same individual.
- 5.3.2 The Observer must also be Qualified to perform the specific task.
- 5.4 The Procedure Flow Charts utilized for the Service Applications Departmental Shipping Procedures involves series and parallel Steps labeled in accordance with the Procedure Step numbers and must be adhered to by the Shipping Department Personnel unless otherwise noted.
- 5.4.1 Series Steps of the flow chart must be accomplished in sequential order.
- 5.4.2 Some parallel Steps are alternatives. Parallel Steps of the flow chart may be accomplished in sequential order or at the same time, whichever is the most efficient.

- 5.5 MURR Personnel involved in any Task within the scope of the Service Applications Departmental Shipping Procedures will receive Documented Initial and Annual Refresher Training applicable to that task in accordance with 49CFR172 Subpart H- Training.
- 5.6 All employees who perform any task subject to the requirements of DOT Hazardous Material Regulations will receive applicable training as described in 49CFR172 in compliance with NRC Information Notice 92-72.

REFERENCES

- A. Code of Federal Regulations, 10CFR.
- B. Code of Federal Regulations, 49CFR.
- C. International Air Transport Association (IATA) Dangerous Goods Regulation
- D. MURR Health Physics Standard Operating Procedures:
- HP-3: Receiving and Opening Packages of Radioactive Material.
  - HP-4: Handling Radioactive Material in MURR Pool.
  - HP-12: Transfer of Radioactive Material within MURR Building.
  - HP-13: MURR Hot Cell Operation.
  - HP-16: Surveying Containers of Radioactive Material for Transport.

Procedure Cover Sheet

MURR-SAS-00002      0      15 April 1993  
(Procedure)                      (Revision)                      (Date)

Hot Cell Preparation of Radioactive Material for Shipment  
(Procedure Title)

Prepared By V.W. Zager  
(Signature)

Reviewed By Mae Carol Stuchler  
(Signature)

Revision Summary

| <u>Rev. #</u> | <u>Date</u> | <u>Significant</u> | <u>Summary</u> |
|---------------|-------------|--------------------|----------------|
| 0             | 15 Apr. 93  | Yes                | Original       |

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HOT CELL PREPARATION OF RADIOACTIVE MATERIAL FOR SHIPMENT1.0 PURPOSE AND SCOPE

This procedure provides instructions for the hot cell preparation of radioactive material to be packaged and shipped by the Service Application Department to ensure Compliance with applicable Regulations of Code of Federal Regulations (CFR), 10CFR, 49CFR and International Air Transport Association (IATA).

## 1.1 This procedure incorporates:

- Positive identification of sample(s) to be removed from the Reactor pool,
- Loading of irradiated sample(s) into a transfer cask,
- Conveyance of transfer cask to the hot cell,
- Transfer of samples into hot cell,
- Removal of sample(s) from the transfer cask,
- Placement of sample(s) into shipping container/ cask,
- Preparation of transfer cask for reuse,
- Transfer of shipping container(s) to packaging area or for In-house processing.

2.0 PRECAUTIONS AND LIMITATIONS

2.1 The non-fixed contamination on any external surface of the transfer cask must be kept as low as practical.

2.1.1 The level of non-fixed radioactive contamination may be determined by wiping an area of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.

2.2 Ensure that all beta-gamma dose rate survey, contamination counting, and gamma radioisotope equipment calibration stickers have not passed the calibration due date prior to use.

- 2.3 Ensure that upon leaving the hot cell area you measure for personal external contamination by use of the Hand-foot monitor (located at the top of the stairs exiting the basement area) or equivalent device.
- 2.3.1 When the Hand-foot monitor alarms indicating external contamination, call Health Physics immediately at extension #2-5217.
- 2.3.2 After 5:00 P.M. or Weekends call the Control Room at extension # 2-5213.
- 2.4 Maintain radiation exposure As Low As Reasonably Achievable (ALARA) by use of Time, Distance, and Shielding, e. g:
- Do not ride down the elevator with the cask containing the samples removed from the Reactor pool.
- 2.5 Ensure that the transfer cask used to transfer the samples from the Reactor pool to the hot cell is wiped and bagged to prevent contamination during its movement.
- 2.5.1 Examine poly bag for holes or tears.
- 2.5.2 Use Extreme Caution when removing the bag from the cask prior to placing the cask into the hot cell to prevent spread of contamination.
- 2.5.3 Use Extreme Caution when placing the bag on the cask prior to moving the cask to a storage area to prevent spread of contamination.
- 2.6 Use protective clothing:
- Laboratory Coats
  - Rubber/Latex Gloves
  - Breathing Masks; Type to minimize ingestion/inhalation of particulate matter.
  - Safety Glasses
- 2.7 In the event of a broken vial or stuck sample, the Reactor Services Engineer or Designee must be notified immediately to resolve the problem.

- 3.0 MATERIALS AND EQUIPMENT
- 3.1 Capintec Radioisotope Calibrator, CRC-5RH or equivalent.
- 3.2 Calibrated gross contamination counting equipment  
Eberline, Model RM-19 or equivalent.
- 3.3 Calibrated Beta counter Eberline, Model BC-4 or equivalent.
- 3.4 Calibrated Radiation Detector Xetex, Model 302B or equivalent.
- 3.5 Smear papers.
- 3.6 Cask handling tools and equipment.
- 3.7 Fork lift.
- 3.8 Clean, uncontaminated shipping container(s):
  - 3.8.1 Type, size, and quantity predetermined by shipping requirements for that day.
- 3.9 Protective clothing, to include:
  - 3.9.1 Rubber/latex gloves
  - 3.9.2 Laboratory coats
  - 3.9.3 Breathing masks, type to minimize ingestion/inhalation of particulate.
  - 3.9.4 Safety Glasses
- 3.10 Bron yellow tape, one inch wide.
- 3.11 Sample Pull Sheet, Attachment 2
- 3.12 Sample Sheet, Attachment 3
- 3.13 Sample Shipment Information Sheet, Attachments 4, 5, 6, and 8.
- 3.14 Existing Loading Sheet, Attachments 7 and 9.
- 3.15 Permanent marker (black ink).
- 3.16 Ball point pen (black ink).

4.0 DEFINITIONS

- 4.1 Activity: Is a measure of the quantity of radioactivity emitted by a radioisotope and is used to determine the amount of radioactive material which may be transported in various types of packaging.
- 4.2 Radioactive Contents: The radioactive material together with any contaminated solids, liquids and gases within the package.
- 4.3 Radioactive material: Any material having a specific activity greater than 70 KBq/kg (0.002 uCi/g).
- 4.4 Sample Log Books: These log books (two) are located in the Control Room and designated as the:
- Flux Trap, H1, and BPLS (Bulk Pool Lead Shield) Book and,
  - Silicon Book.

The log books are broken down into sections designated to correspond with the reactor irradiation and in-pool storage area.

- 4.4.1 "Sample Run Sheets" are placed in the appropriate Section of the log books during irradiation of the sample, after which, they are moved to the Storage Section.
- 4.4.2 The stored position is recorded on the Sample Run Sheet.
- 4.4.3 The Flux Trap, H1, and BPLS Book consists of the following sections: Flux Tray Loading Sheet, Tube A, Tube B, Tube C, H1, BPLS (Bulk Pool Lead Shield), Bisco, Storage, Reuter Stokes, and Samples in use.
- 4.4.4 The Silicon Book consists of: J-1, K-2, R (Red, also known as "J") LL3, L positions, N positions, B (Blue, also known as I), Y (Yellow, also known as H), G (Green also know as G), Bin Storage, and Sample Storage.
- 4.5 Shall, Must, Should:
- 4.5.1 Shall: Regulatory Commitment to Code of Regulations, 10CFR, 49CFR and IATA Dangerous Goods Regulations.
- 4.5.2 Must: MURR Internal Commitment to 10CFR, 49CFR and IATA Regulations.
- 4.5.3 Should: Should be accomplished; not required.
- 4.6 Shipping container: To contain the sample(s) during transport: Can be a lead pig (2 LB. to 30 LB), or a depleted uranium shield.

- 4.7 Specific Activity: The activity of the radionuclide per unit weight of that nuclide.
- 4.8 Transfer Cask: Used to transport samples within the facility.
- 5.0 RESPONSIBILITIES
- 5.1 Reactor Services Engineer: Ensure that all shipments of radioactive material conform to applicable Regulations of 10CFR, 49CFR, and IATA. Provide properly certified packages for shipment of radioactive materials.
- 5.2 Health Physics Manager: Provide Health Physics (HP) support as required to Service Applications Group for preparation of radioactive material shipments.
- 5.3 Reactor Operations Manager: Provide round the clock Operations support as required to Service Applications Group for irradiation of samples received.
- 6.0 PROCEDURE
- 6.1 Ensure that Consignees (Receivers) for MURR Shipments of radioactive materials are properly authorized to receive the Type, Form, and Quantity of such material in accordance with Provisions of 10CFR.
- 6.2 The following unique characteristics of each shipment shall be maintained throughout Receipt, Safety Analysis, Preparation for Irradiation, Irradiation, Post Irradiation Processing, Packaging, and Documentation:
- 6.2.1 Material Description,
- 6.2.2 Amount (Mass),
- 6.2.3 Isotopes,
- 6.2.4 Activity,
- 6.2.5 Destination,
- 6.2.6 Recipient's License Number, Amendment Number and Expiration Date or certificate in accordance with 10CFR.
- 6.2.7 MURR Identification Number.

- 6.3 Data integrity must be maintained by documented Control Check Sheets with Independent Verification at critical points in the process.
- 6.3.1 The "Performer" of a shipping process and "Independent Redundant Verifier" must not be the same individual.
- 6.3.2 The Independent Verifier must also be Qualified to perform the Task.
- 6.4 MURR Personnel involved in any Task within the scope of this Procedure will receive Documented Initial and Annual Refresher Training applicable to that Task in accordance with 49CFR172 Subpart H- Training.
- 7.0 HOT CELL PROCESSING FLOW PATH
- 7.0.1 The Hot Cell Flow Path Chart (attachment 1) involves series and parallel steps labeled in accordance with the Procedure step numbers and must be adhered to by the Shipping Department Personnel unless otherwise noted.
- 7.0.2 Series steps of the flow chart must be accomplished in sequential order.
- 7.0.3 Some parallel steps are alternative parallel steps of the flow chart and may be accomplished in sequential order or at the same time, whichever is the most efficient, for example:
- 7.0.3.1 Step 7.5 (Prepare Shipping Containers to receive sample(s)) does not have to be completed immediately after Step 7.1 (Determine Shipment Type and Prioritize) but must be completed prior to Step 7.6 (Hot Cell Entry).
- 7.0.4 Processing of the radioisotopes prior to packaging for shipment is accomplished in cooperation with MURR Operations (OPS), Health Physics (HP) and Service Applications (SA) Departments.

7.1 DETERMINE SHIPMENT TYPE AND PRIORITIZE

Use the Sample Pull Sheet (Attachment 2) and Sample Shipment Information Sheer (Attachment 4): Review specified shipping container to determine if appropriate and prioritize the shipping orders set for the day.

7.1.1 The Service Applications Section Leader-Shipping or Authorized Individual will determine priority based on prior knowledge and/or discussion with consignees.

7.1.2 General Guidelines to determine shipping priority:

1. In general, "Human Use" will have the highest priority.
2. Samples which have been retained beyond their requested ship date will have the next highest priority.
3. Others are:
  - Long lived isotopes,
  - Standard Air (two day delivery service)

7.1.3 "A" Priority samples are high-lighted in pink on the Sample Pull Sheet (attachment 2).

7.1.4 "B" Priority samples are high-lighted in blue on the Sample Pull Sheet (attachment 2).

7.2 PREPARATION FOR SAMPLE REMOVAL FROM POOL

7.2.1 Transport Transfer Cask and Sample Pull Sheer (Attachment 2) to the Control Room.

7.2.2 Remove the Sample Sheet, (Attachment 3) from the Control Room Sample Log Book in accordance with the information provided by the Sample Pull Sheet (Attachment 2).

7.2.3 Verify the following information from the Sample Pull Sheet: (Attachment 2) and Sample Sheet (Attachment 3):

- Can number
- Company (destination)
- Proper decay time

- 7.3 REMOVE SAMPLE(S) FROM POOL
- 7.3.1 Qualified Shipper ensures can ID number corresponds to Sample Pull Sheet (Attachment 2).
- 7.3.2 Operators assisted by Health Physics:
- 7.3.2.1 Load samples into transfer cask.
- 7.3.2.2 Install lid on transfer cask.
- 7.3.2.3 Raise transfer cask from pool
- 7.3.2.4 H.P. monitor transfer cask for dose rate.
- 7.3.2.5 Insert drain plug into transfer cask when cask is drained.
- 7.3.2.6 Rinse transfer cask with distilled water.
- 7.3.2.7 Wipe down outside of transfer cask.
- 7.3.3 Inspect the plastic bag to be used to insert transfer cask into for holes or tears.
- 7.3.4 Install safety bar and pin in cask.
- 7.3.5 Place transfer cask into the plastic bag.
- 7.3.6 Assure proper orientation of cart to accommodate cask.
- 7.3.7 Place transfer cask on a cart.
- 7.4 TRANSPORT SAMPLE(S) TO HOT CELL

**\*\* CAUTION \*\***

*Personnel transporting cask to hot cell must practice ALARA , (TIME , DISTANCE, SHIELDING)*

**DO NOT RIDE ELEVATOR WITH CASK.**

- 7.4.1 Transfer cask is transported to the hot cell via the Containment and Freight elevators or door 101 when available.
- 7.4.2 Occasionally, two transfer casks are used. Second transfer cask is stored in the "hot closet" located in the basement at the foot of the stairs.

7.5 PREPARE SHIPPING CONTAINERS TO RECEIVE SAMPLE(S)

7.5.1 Ensure shipping container is clean of all previous identifiers:

- If the shipping container has previously been used, remove all prior markings.

7.5.2 Use the Sample Shipment Information Sheet (Attachment 4, Step 1) and permanent marker (black) to legibly mark and identify the shipping container with the following information:

- A. Sample can number or capsule number,
- B. Company,
- C. Isotope,
- D. MURR Identification number.

7.5.2.1 In-house samples are taped with three inch wide yellow tape and then the above information is written on the tape.

7.5.3 Verify the information of Step 7.5.2 on the shipping shield before placing in processing area.

7.5.4 Performer and Independent Observer initial Step 1 completion, (Attachment 4).

7.6 HOT CELL ENTRY

7.6.1 Qualified Shipper dons protective clothing:

- Laboratory coat
- Rubber/latex gloves
- Breathing mask; type to minimize ingestion/inhalation of particulate matter for personnel who approach the hot cell door.
- Safety Glasses/face shield

7.6.2 Move transfer table to North end of hot cell.

7.6.3 **Health Physics:**

7.6.3.1 Ensure air monitor is functional.

7.6.3.2 Ensure hot cell blower is "ON".

7.6.3.3 Open concrete shield outer door to hot cell and survey inner door of hot cell while outer door is opening.

## 7.6.4 Qualified Shipper:

- 7.6.4.1 Open aluminum inner wall door.
- 7.6.4.2 Place clean absorbent paper on Pig Tray in hot cell.
- 7.6.4.3 Load the clean, identified shipping containers on the pig tray in the hot cell with the identifying markings facing the South window at approximately a 45 degree angle.
- 7.6.4.4 Move the transfer cask to the front of the hot cell door by a fork lift.
- 7.6.4.5 Remove safety pin and bar from cask.
- 7.6.4.6 Remove the plastic bag from the transfer cask at the hot cell door.

## 7.6.5 Health Physics:

- 7.6.5.1 Insert transfer cask into hot cell with fork lift.
- 7.6.5.2 Close inner hot cell aluminum door.
- 7.6.5.3 Swipe floor outside of hot cell and read for contamination.
- 7.6.5.4 Close outer concrete door.
- 7.6.5.5 Turn hot cell blower "OFF".

7.7 REMOVE CAN FROM TRANSFER CASK

- 7.7.1 Lift lid from transfer cask using the crane.
- 7.7.2 Remove transfer cask basket and place on upper work table.
- 7.7.3 Manipulate sample can from the transfer cask basket and place can in holding area.

## NOTE:

WHEN PROCESSING HOST CANS (Mondays),  
DO NOT REPLACE BASKET IN LAST TRANSFER CASK.

- 7.7.4 Place basket into transfer cask.
- 7.7.5 Set transfer cask lid in place.
- 7.7.6 Unhook lid from crane.

- 7.7.7 Identify and verify the can by comparing the can with the Sample Shipment Information Sheet (Attachment 4), Step 2, when applicable.
- 7.7.8 Performer and Observer initial to verify sample can is correct (Attachment 4) Step 2.
- *NOTE: AT THIS POINT IN THE HOT CELL PROCESSING, THE SAMPLE CAN MAY TAKE ONE OF TWO PATHS:*
    1. The Sample Can is to be Loaded into a Shipping Container for Shipment: Proceed to Procedure Step 7.12 or,
    2. The Sample Can is to be opened and contents processed: Proceed to Procedure Step 7.8.
- 7.7.9 The transfer cask will be removed from the hot cell in Step 7.13.
- 7.8 OPEN CAN AND PROCESS
- *NOTE: The term "Process" in Steps 7.8.4 and 7.8.5 means either processing a sample, or removing a capsule without opening the capsule.*
- To process a sample, go from Step 7.8.3 to 7.8.4.
- To remove a capsule, go from Step 7.8.3 to 7.8.7.
- 7.8.1 Sample can is identified and verified by comparing the can inscription with Sample Shipment Information Sheet, (Attachment 5) Step 2.
- 7.8.2 Performer and Observer initial Sample Shipment Information Sheet (Attachment 5), Step 2, verifying sample can is correct.
- 7.8.3 Cut top off of sample can and place top into hot waste storage area of hot cell.

7.8.4 Process Sample

- 7.8.4.1 Remove sample from sample can and place on clean absorbent paper.
- 7.8.4.2 Perform a visual inspection of the sample after it is de-canned as shown in example on Sample Shipment Information Sheet (Attachment 5), upper right corner:
- OPEN 4" CAN.  
THREE VIALS
- 7.8.4.3 Performer and Observer initial Step 3 of Sample Shipment Information Sheet (Attachment 5).
- 7.8.5 If sample activity is to be measured in the Capintec:
- 7.8.5.1 The lid of the Calibrator cask is raised by the crane, exposing the CRC-5RH Detector.
- 7.8.5.2 The scale of the Calibrator, CRC-5RH detector is adjusted for the specific isotope setting (window).
- 7.8.5.3 Record the Date, Time, and Capintec Setting on Sample Shipment Information Sheet (Attachment 5), Step 4.
- 7.8.5.4 The sample is manipulated into the detector in a plastic holder.
- 7.8.5.5 Activity of the sample is measured by the CRC-5RH Calibrator.
- 7.8.5.6 Record the Capintec readings on Sample Shipment Information Sheet, (Attachment 5) Step 4.
- 7.8.5.7 Performer and Observer initial (Step 4) of Sample Shipment Information Sheet (Attachment 5).
- 7.8.6 To load processed sample into shipping container: Proceed to Procedure Step 7.12.

7.8.7 Process capsule

- 7.8.7.1 Identify and verify capsule inscription by comparing the inscription and capsule design on Sample Shipment Information Sheet (Attachment 6), and Existing Loading Sheet (Attachment 7).
- 7.8.7.2 Performer and Observer initial Step 2 of Sample Shipment Information Sheet (Attachment 6).
- 7.8.7.3 Perform a visual inspection of the capsule as shown in wording description box in the upper right hand corner of Attachment 6:

## DO NOT OPEN CAPSULE 1

- 7.8.7.4 Performer and Observer initial Sample Shipment Information Sheet (Attachment 6), Step 3.
- 7.8.8 If capsule activity is to be measured in the Capintec:
- 7.8.8.1 The lid of the calibrator cask is raised by the crane, exposing the CRC-5RH detector.
- 7.8.8.2 The scale of the calibrator CRC-5RH detector is adjusted for the specific isotope setting (window).
- 7.8.8.3 Record the Date, Time, and Capintec setting On Sample Shipment Information Sheet (Attachment 6) Step.
- 7.8.8.4 The capsule is manipulated into the detector in a plastic holder.
- 7.8.8.5 Activity of the capsule is measured by the CRC-5RH Calibrator.
- 7.8.8.6 Record the Capintec readings on the Sample Shipment Information Sheet, (Attachment 6) Step 4.
- 7.8.8.7 Performer and Observer initial (Step 4) of the Sample Shipment Information Sheet (Attachment 6).

## • NOTE:

AT THIS POINT IN THE HOT CELL PROCESS, THE CAPSULE MAY TAKE ONE OF FOUR PATHS:

1. Capsule is to be placed in Storage: Proceed to Step 7.9.
2. Capsule is to be Opened and Processed: Proceed to Step 7.10.
3. Capsule is to be Reloaded: Proceed to Step 7.11 or,
4. Capsule is to be loaded into shipping container: Proceed to Step 7.12.

7.9 STORAGE

7.9.1 When capsules are placed into or removed from the hot cell storage area, the following information must be written into the Hot Cell Storage Log Book:

- Date In and Out as applicable
- MURR Identification Number
- Capsule Number
- Capsule Design
- Position Stored
- "In" Initials
- "Out" Initials
- Remarks

7.9.2 The capsule(s) unloaded in Procedure Step 7.8 (Open Can and Process) may be placed in storage for one of these later actions:

1. If it is to be opened and processed: Proceed to Step 7.10,
2. If it is to be reloaded: Proceed to Step 7.11 or,
3. If it is to be loaded into a shipping container: Proceed to Step 7.12.

7.10 OPEN CAPSULE AND PROCESS

- 7.10.1 Place capsule in bucket and transfer to South work station.
- 7.10.2 Place capsule on clean absorbent paper.
- 7.10.3 Identify and verify capsule inscription by comparing the inscription on Sample Shipment Information Sheet (Attachment 8), and Existing Loading Sheet (Attachment 9).
- 7.10.4 Performer and Observer initial Step 2, of Sample Shipment Information Sheet (Attachment 8).

- 7.10.5 Perform a visual inspection of the capsule as shown in the upper right hand corner of Sample Shipment Information Sheet (Attachment 8) :
- ONE VIAL OPEN CAPSULE 1
- 7.10.6 Performer and Observer initial Sample Shipment Information Sheet (Attachment 8), Step 3.
- 7.10.7 Open the capsule and remove sample.
- 7.10.8 If sample activity is to be measured in the Capintec:
- 7.10.8.1 The lid of the calibrator is raised by the crane, exposing the CRC-5RH Detector.
- 7.10.8.2 The scale of the calibrator CRC-5RH detector is adjusted for the specific isotope setting (window).
- 7.10.8.3 Record the Date, Time, and Capintec Setting on Sample Shipment Information Sheet (Attachment 8) Step 4.
- 7.10.8.4 The sample is manipulated into the detector in a plastic holder.
- 7.10.8.5 Activity of the sample is measured by the CRC-5RH Calibrator.
- 7.10.8.6 Record the Capintec readings on Sample Shipment Information Sheet, (Attachment 8) Step 4.
- 7.10.8.7 Performer and Observer initial (Step 4) of Sample Shipment Information Sheet (Attachment 4).
- 7.10.9 To load sample removed from capsule into shipping container: Proceed to Procedure Step 7.12.
- 7.11 RELOAD
- 7.11.1 Capsules to be reloaded will be received from:
1. Open Can and Process: Procedure Step 7.8
  2. Storage: Procedure Step 7.9
- 7.11.2 To reload: Use MURR-SAS-00005.

7.12 LOAD INTO SHIPPING CONTAINER

The loading of the shipping container may occur from one or as many as five different sources:

- An un-opened, un-processed can from Step 7.7.
- A processed sample from Step 7.8.,
- A processed capsule from Step 7.8.2.
- A stored capsule from Step 7.9.
- A capsule which has been opened and processed from Step 7.10 or,

7.12.1 Identify correct shipping container.

7.12.2 Load identified can/sample/capsule into appropriate shipping container.

7.12.3 Performer and Observer initial Sample Shipment Information Sheet, Step 5 (Attachment 4, 5, 6, or 8), indicating can/sample/capsule is loaded into correct vial container, shipping pig or depleted uranium shield.

## NOTE:

Replacement of lids on some depleted uranium shields require the use of the crane.

7.12.3.1 Replace lid on depleted uranium shield with crane if appropriate.

7.13 REMOVE CASKS FROM HOT CELL

## NOTES:

PERFORM A VISUAL INSPECTION OF THE HOT CELL TO ENSURE THAT ALL WORKING AREAS ARE SECURED AND THAT DOORS CAN BE OPENED.

MOVE TRANSFER TABLE TO NORTH END OF HOT CELL AND ADJUST TO CORRECT LEVEL FOR FORK LIFT ENTRY.

## 7.13.1 Health Physics:

7.13.1.1 Turn hot cell blower "ON".

7.13.1.2 Open concrete shield outer door to hot cell and survey inner door of hot cell while door is opening.

7.13.1.3 Open aluminum inner wall door.

## 7.13.2 Qualified Shipper:

7.13.2.1 Place lid(s) on shipping container(s) by hand.

7.13.2.2 Swipe all shipping containers and transfer cask(s).

7.13.2.3 Remove shipping container(s) from hot cell.

7.13.2.4 Place shipping containers on absorbent paper covered work table.

## 7.13.3 Health Physics:

7.13.3.1 Perform dose rate measurements of shipping container(s) and transfer cask(s) using Ion Chamber, Eberline model RO-2A or equivalent.

## 7.13.4 Qualified Shipper/Health Physics:

7.13.4.1 Inspect poly bag to be used to bag the transfer cask for holes or tears.

7.13.4.2 Remove transfer cask from hot cell using fork lift.

7.13.4.3 Bag the transfer cask.

7.13.4.4 Replace safety bar and pin.

## 7.13.5 Health Physics:

7.13.5.1 Close the inner hot cell door.

7.13.5.2 Close outer hot cell door.

7.13.5.3 Turn hot cell blower "OFF"

7.13.5.4 Swipe and read floor outside of the hot cell door using Baird Polyspec Research Spectrometer or equivalent to count the swipes.

7.13.6 On approval by Health Physics, indicating containers are clean to ship, tape shipping container lid to the shipping container with Bron one inch wide yellow tape.

7.13.7 After the shipping containers are swiped, read and approved by Health Physics, the yellow taped shipping containers are loaded onto a cart and may be dispatched to:

- The packaging area for packaging: Use MURR-SAS-00004, Shipping Procedure or,
- In-house processing.

7.14 PREPARE TRANSFER CASK FOR REUSE

7.14.1 Clean transfer cask if required in preparation for future sample removal from the pool.

7.15 COMPLETE PAPER WORK

7.15.1 The following paper work is transferred between Service Applications-Shipping and Service Applications-Isotopes:

- Sample Pull Sheet, Attachment 2.
- Sample Sheet, Attachment 3.
- Sample Shipment Information Sheets, Attachments 4, 5, 6, and 8.
- Existing Loading Sheets, Attachments 7 and 9. (Mondays only for host can loading).

7.15.2 Originally, the above paper work is generated by Service Applications-Isotopes and transferred to Service Applications-Shipping.

7.15.3 Prior to when the Shippers go to the hot cell the Sample Sheet is returned to Isotopes.

7.15.3.1 Isotopes enters the information of the Sample Sheet into the Data Base.

7.15.3.2 The Sample Sheet is returned to Shipping.

7.15.4 After the package is shipped the Documentation Packet, which includes, the Sample Sheet and Sample Shipment Information Sheet is returned to Isotopes where it remains until Billing.

7.15.4.1 The Sample Pull Sheet is filed by the Shipping Department.

7.15.4.2 On Mondays (host can loading) the Existing Loading Sheet is returned by placing it into the "In-basket" of Isotopes.

7.15.5 After the Billing, the paper work is transferred to Service Applications Section Leader- Shipping.

7.15.6 The Service Applications Section Leader- Shipping:

- Files the paper work in numerical order and maintains this paper work for a period of three years.
- Performs sampling of the documents for accuracy.

7.15.7 After a three year period, this paper work is sent to the University of Missouri Storage.

ATTACHMENTS

- A. Hot Cell Sample Flow sheet, Attachment 1.
- B. Sample Pull sheet, Attachment 2.
- C. Sample sheet, Attachment 3.
- D. Sample Shipment Information Sheet, Attachments 4, 5, 6, and 8.
- E. Existing Loading Sheet, Attachments 7 and 9.

REFERENCES

- A. Health Physics Standard Operating Procedures:
  - 1. HP-4: Handling Radioactive Material in MURR Pool.
  - 2. HP-12: Transfer of Radioactive Material within MURR building.
  - 3. HP- 13: MURR Hot Cell Operation

Procedure Cover Sheet

MURR-SAS-00003      0      15 April 1993  
(Procedure)      (Revision)      (Date)

Hot Laboratory Preparation of Radioactive Material for Shipment  
(Procedure Title)

Prepared By V.W. Zagar  
(Signature)

Reviewed By Max Carter Gitschler  
(Signature)

Revision Summary

| <u>Rev. #</u> | <u>Date</u>  | <u>Significant</u> | <u>Summary</u> |
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HOT LABORATORY PREPARATION OF RADIOACTIVE MATERIAL FOR SHIPMENT

1.0 PURPOSE AND SCOPE

This procedure provides instructions for the hot laboratory preparation of radioactive material to be packaged and shipped by the Service Application Department to ensure Compliance with applicable Regulations of Code of Federal Regulations (CFR), 10CFR, 49CFR and International Air Transport Association (IATA).

1.1 This procedure incorporates:

- Positive identification of sample(s) to be removed from the Reactor pool,
- Loading of irradiated sample(s) into a Transfer Cask,
- Conveyance of Transfer Cask to the hot laboratory,
- Transfer of samples into hot laboratory hood,
- Process of sample(s) into shipping container,
- Preparation of transfer cask for reuse,
- Transfer of shipping container(s) to packaging area or for In-house processing.

2.0 PRECAUTIONS AND LIMITATIONS

2.1 The non-fixed contamination on any external surface of the transfer cask must be kept as low as practical.

2.1.1 The level of non-fixed radioactive contamination may be determined by wiping an area of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.

2.2 Ensure that all beta-gamma dose rate survey, contamination counting, and gamma radioisotope equipment calibration stickers have not passed the calibration due date prior to use.

- 2.3 Ensure that upon leaving the hot laboratory area you measure for personal external contamination by use of the Hand-foot monitor or equivalent device.
- 2.3.1 When the Hand-foot monitor alarms indicating external contamination, call Health Physics immediately at extension #2-5217.
- 2.3.2 After 5:00 P.M. or Weekends call the Control Room at extension # 2-5213.
- 2.4 Maintain radiation exposure As Low As Reasonably Achievable (ALARA) by use of Time, Distance, and Shielding, e.g:
- Do not ride down the elevator with the cask containing the samples removed from the Reactor pool.
- 2.5 Use protective clothing:
- Laboratory Coats
  - Rubber/Latex Gloves and long sleeve plastic gloves.
  - Safety glasses and/or Face Shield.
- 2.6 In the event of a stuck sample or broken vial, the Reactor Services Engineer or designee must be notified immediately.

3.0 MATERIALS AND EQUIPMENT

- 3.1 Calibrated gross contamination counting equipment.
- 3.2 Calibrated Beta counter.
- 3.3 Smear papers.
- 3.4 Cask handling tools and equipment.
- 3.5 Clean, uncontaminated shipping container(s):
  - 3.5.1 Type, size, and quantity predetermined by shipping requirements for that day.
- 3.6 Protective clothing, to include:
  - 3.6.1 Rubber/latex gloves and long sleeve plastic gloves.
  - 3.6.2 Laboratory coats.
  - 3.6.3 Safety glasses or face shield.
- 3.7 Bron yellow tape, one inch wide.
- 3.8 Sample Pull Sheet, Attachment 2
- 3.9 Sample Sheet, Attachment 3
- 3.10 Sample Shipment Information Sheet, Attachment 4
- 3.11 Permanent marking pen (black ink).
- 3.12 Kay Dries®.

4.0 DEFINITIONS

4.1 Activity: Is a measure of the quantity of radioactivity emitted by a radioisotope and is used to determine the amount of radioactive material which may be transported in various types of packaging.

4.2 Hot Laboratory: A controlled area to process radioactive materials containing the following:

4.2.1 A hood which exhausts to the Reactor air exhausts and a drain for liquids to hot waste.

4.3 Radioactive Contents: The radioactive material together with any contaminated solids, liquids and gases within the package.

4.4 Radioactive material: Any material having a specific activity greater than 70 KBq/kg (0.002 uCi/g).

4.5 Sample Log Books: These log books (two) are located in the Control Room and designated as the:

- Flux Trap, H1, and BPLS (Bulk Pool Lead Shield) Book and,
- Silicon Book.

The log books are broken down into sections designated to correspond with the reactor irradiation and in-pool storage area.

4.5.1 "Sample Run Sheets" are placed in the appropriate Section of the log books during irradiation of the sample, after which, they are moved to the Storage Section.

4.5.2 The stored position is recorded on the Sample Run Sheet.

4.5.3 The Flux Trap, H1, and BPLS Book consists of the following sections: Flux Tray Loading Sheet, Tube A, Tube B, Tube C, H1, BPLS (Bulk Pool Lead Shield), Bisco, Storage, Reuter Stokes, and Samples in use.

4.5.4 The Silicon Book consists of: J-1, K-2, R (Red, also known as "J") LL3, L positions, N positions, B (Blue, also known as I), Y (Yellow, also known as H), G (Green also know as G), Bin Storage, and Sample Storage.

4.5 Shall, Must, Should:

4.5.1 Shall: Regulatory Commitment to Code of Regulations, 10CFR, 49CFR and IATA Dangerous Goods Regulations.

4.5.2 Must: MURR Internal Commitment to 10CFR, 49CFR and IATA Regulations.

4.5.3 Should: Should be accomplished; not required.

4.6 Shipping container: To contain the sample(s) during transport: Can be a lead pig (2 LB. to 30 LB), or a depleted uranium shield.

4.7 Specific Activity: The activity of the radionuclide per unit weight of that nuclide.

4.8 Transfer Cask: Used to transport samples within the facility.

4.8.1 The Orange Roll Up Cask is included as a transfer cask.

5.0 RESPONSIBILITIES:

5.1 Reactor Services Engineer: Ensure that all shipments of radioactive material conform to applicable Regulations of 10CFR, 49CFR, and IATA. Provide properly certified packages for shipment of radioactive materials.

5.2 Health Physics Manager: Provide Health Physics (HP) support as required to Service Applications Group for preparation of radioactive material shipments.

5.3 Reactor Operations Manager: Provide round the clock Operations support as required to Service Applications Group for irradiation of samples received.

6.0 PROCEDURE

- 6.1 Ensure that Consignees (Receivers) for MURR Shipments of radioactive materials are properly authorized to receive the Type, Form, and Quantity of such material in accordance with Provisions of 10CFR.
- 6.2 The following unique characteristics of each shipment Shall be maintained throughout Receipt, Safety Analysis, Preparation for Irradiation, Irradiation, Post Irradiation Processing, Packaging, and Documentation:
- 6.2.1 Material Description,
- 6.2.2 Amount (Mass),
- 6.2.3 Isotopes,
- 6.2.4 Activity,
- 6.2.5 Destination,
- 6.2.6 Recipient's License Number, Amendment Number and Expiration Date or certificate in accordance with 10CFR.
- 6.2.7 MURR Identification Number.
- 6.3 Data integrity must be maintained by documented Control Check sheets with Independent Verification at critical points in the process.
- 6.3.1 The "Performer" of a shipping process and "Independent Redundant Verifier" must not be the same individual.
- 6.3.2 The Independent Verifier must also be Qualified to perform the Task.
- 6.4 MURR Personnel involved in any Task within the scope of this Procedure will receive Documented Initial and Annual Refresher Training applicable to that Task in accordance with 49CFR172 Subpart H- Training.

7.0 HOT LABORATORY FLOW CHART

7.0.1 The Hot Laboratory Flow Chart (Attachment 1) involves series and parallel steps labeled in accordance with the Procedure Step numbers and must be adhered to by the Shipping Department Personnel unless otherwise noted.

7.0.2 Series steps of the flow chart must be accomplished in sequential order.

7.0.3 Some parallel steps are alternatives. Parallel steps of the flow chart may be accomplished in sequential order or at the same time, whichever is the most efficient, for example:

7.0.3.1 Step 7.5 ( Prepare Shipping Containers and Hot Laboratory) does not have to be completed immediately after Step 7.1 (Determine Shipment Type and Prioritize) but must be completed prior to Step 7.6 (Remove Can from Cask).

7.0.4 Processing of the radioisotopes prior to packaging for shipment is accomplished in cooperation with MURR Operations (OPS), Health Physics (HP) and Service Applications (SA) Departments.

7.1 DETERMINE SHIPMENT TYPE AND PRIORITIZE

Use the Sample Pull Sheet (Attachment 2): Review specified shipping container to determine if appropriate and prioritize the shipping orders set for the day.

7.1.1 The Service Applications Section Leader-Shipping or Designee will determine priority based on prior knowledge and/or discussion with consignees.

7.1.2 General Guidelines to determine shipping priority:

1. In general, "Human Use" will have the highest priority.
2. Samples which have been retained beyond their requested ship date will have the next highest priority.
3. Others are:

- Long lived isotopes,
- Standard Air (two day delivery service)

7.1.3 "A" Priority samples are high-lighted in pink on the Sample Pull Sheet (Attachment 2).

7.1.4 "B" Priority samples are high-lighted in blue on the Sample Pull Sheet (Attachment 2).

7.2 PREPARATION FOR SAMPLE REMOVAL FROM POOL

7.2.1 Procure cask and check for:

- Safety rod and safety pin are in place.
- Proper operation of the lid and cable.

7.2.2 Transport Transfer Cask and Sample Pull Sheet (Attachment 2) to the Control Room.

7.2.3 Remove the Sample Sheet, (Attachment 3) from the Control Room Sample Log Book in accordance with the information provided by the Sample Pull Sheet (Attachment 2).

7.2.4 Verify the following information from the Sample Pull Sheet: (Attachment 2) and Sample Sheet (Attachment 3):

- Can number
- Company/Destination

7.3 REMOVE SAMPLE(S) FROM POOL

7.3.1 Qualified Shipper ensures can ID number corresponds to Sample Pull Sheet (Attachment 2) and Sample Shipment Information Sheet (Attachment 4).

*NOTE:*

*Sample(s) pulled from pool must read 10R/hr or less.*

7.3.2 Operators assisted by Qualified Shippers and Health Physics:

7.3.2.1 Monitor sample as it is being pulled.

7.3.2.2 Load sample(s) into transfer cask.

7.3.2.3 Install lid on cask.

7.3.2.4 Secure lid on cask with safety rod and safety pin.

7.3.2.5 Health Physics monitor cask for dose rate.

7.4 TRANSPORT SAMPLE(S) TO HOT LABORATORY

**\*\* CAUTION \*\***

- Personnel transporting cask to hot laboratory must practice ALARA, (TIME, DISTANCE, SHIELDING)

**DO NOT RIDE ELEVATOR WITH CASK.**

7.4.1 Transfer cask is transported to the hot laboratory via the Containment elevator.

7.5 PREPARE SHIPPING CONTAINERS AND HOT LABORATORY

7.5.1 Ensure shipping container is clean of all previous identifiers:

- If the shipping container has previously been used, remove all prior markings.

7.5.2 Use the Sample Shipment Information Sheet (Attachment 4), Step 1, and permanent marking ink pen to mark and identify the shipping container with the following information:

- A. Sample can number,
- B. Company,
- C. Isotope and,
- D. MURR Identification number.

7.5.2.1 If a vial pig is used for an in-house sample the above information is written on 3" wide tape and then applied to the vial pig.

7.5.3 Verify the information of Step 7.5.2 on the shipping shield before placing in processing area.

7.5.4 Performer and Observer initial Step 1 completion, (Attachment 4).

7.5.5 Qualified Shipper dons protective clothing:

- Safety glasses and/or face shield
- Laboratory coat.
- Rubber/latex gloves and long sleeve plastic gloves.

- 7.5.6 Prepare laboratory table to receive samples for processing:
- 7.5.6.1 Cover table area with Kay Dries®.
- 7.5.6.2 Place radiation meter on table.
- 7.5.6.3 Turn radiation meter "ON" and set meter to 10 R/hr. scale.
- 7.5.7 Turn hood light "ON".
- 7.5.8 Check battery to audible dosimeter, type ACCU-CHIRP or equivalent, located to the right of hood opening.
- 7.5.9 Verify operation of audible dosimeter.
- 7.5.10 Verify sample can size from description in the Sample Description Block of Sample Shipment Information Sheet (Attachment 4), for example:

OPEN 2X5" FLOODED CAN, TWO  
BUNDLES OF VIALS IN FOIL

- 7.5.11 Adjust can opener to accommodate correct sample can size.
- 7.6 REMOVE CAN FROM CASK

*CAUTIONS:*

- *BEFORE UNLOADING THE SAMPLE, CLEAR THE ROOM OF ALL UNNECESSARY PERSONNEL.*
- *DO NOT DRIP WATER FROM TRANSFER CASK ON THE CASK, FLOOR, TABLE, etc.*

- 7.6.1 Remove the can from the transfer cask.
- 7.6.1.1 Put the removed can in the hood behind the lead wall.
- 7.6.2 For preparation of the transfer cask for reuse: Proceed to Step 7.13
- 7.7 IDENTIFY CAN
- 7.7.1 Identify and verify the can by comparing the can inscription with Sample Shipment Information Sheet, (Attachment 4), Step 2, when applicable.
- 7.7.2 Performer and Observer initial to verify sample can is correct (Attachment 4) Step 2.

7.8 OPEN CAN

*NOTE: IF THE CAN IS A FLOODED RUN, FIRST DRAIN WATER INTO FUNNEL ON LEFT SIDE OF HOOD.*

7.8.1 Load the can to be opened in the can opener.

7.8.2 Tighten the base of the can opener on the can.

7.8.3 Turn "on" the can opener.

*CAUTION: BE CAREFUL NOT TO FORCE THE BLADE OF CAN OPENER. THIS MAY CAUSE THE CAN TO DENT OR BEND AND WILL MAKE IT DIFFICULT TO REMOVE THE SAMPLE.*

7.8.4 Slowly move the blade in on the can.

7.8.5 Shut "off" the can opener when can is opened.

7.8.6 Place the lid in the "hot waste" large can for disposal.

7.8.7 Move the cutting edge of the can opener away from the can.

7.9 PROCESS SAMPLE

*NOTE: FLOODED SAMPLES ARE TO BE PLACE IN PLASTIC ZIP LOCK BAGS AND SEALED.*

7.9.1 View the sample in the mirror at the top of the hood.

7.9.1.1 If sample does not appear to be intact, stop and contact the Service Applications Section Leader-Shipping or Designee before proceeding.

*NOTE: ENSURE SHIPPING CONTAINER IS READY TO RECEIVE THE SAMPLE per Step 7.5 (Preparation)*

*WORK QUICKLY TO MAINTAIN ALARA.*

7.9.2 Using tweezers, remove sample from can.

7.9.3 Identify and verify the sample by comparing the sample with the description shown in the Sample Description Block located in the upper right hand corner of Sample Shipment Information Sheet (Attachment 4), e.g.:

OPEN 2X5" FLOODED CAN, TWO BUNDLES OF VIALS IN FOIL

7.9.4 Performer and Observer initial Sample Shipment Information Sheet (Attachment 4), Step 3.

- 7.10 LOAD INTO SHIPPING CONTAINER
- 7.10.1 Identify correct shipping container.
- 7.10.2 Load identified sample into appropriate shipping container.
- 7.10.3 Performer and Observer initial Sample Shipment Information Sheet (Attachment 4), Step 5, indicating sample is loaded into correct shipping container.
- 7.10.4 Perform dose measurements on shipping container.
- 7.10.4.1 Record dose reading in top, right hand corner (above Description Block) on Sample Shipment Information Sheet (Attachment 4).
- 7.10.4.2 If container is for in- house, put dose measurement on container, e.g., zip lock bag or lead pig.
- 7.10.5 Remove gloves.
- 7.10.6 Put on fresh gloves.
- 7.10.7 Swipe shipping container.
- 7.10.7.1 Use Hand, Foot Monitor for personal contamination check on way to reading swipe of container.
- 7.10.7.2 Read swipe to monitor for gross contamination.
- 7.10.7.3 If swipe indicates contamination: decontaminate with masaline until further swiping indicates free of contamination.
- 7.10.8 After the swipe is read, indicating container is free of contamination:
- 7.10.8.1 Tape only rigid shipping container(s) with Bron one inch wide ye'llow tape.

7.10.9 The shipping container may go to:

1. In-house User: Proceed to Step 7.11 or,
2. Packaging Area: Proceed to Step 7.12.

7.11 SHIPPING CONTAINER TO IN-HOUSE USER

7.11.1 If sample is in a bag for in-house user, place sample in the cave by the hood.

7.11.1.1 If a lead pig is used, place in holding area.

7.12 SHIPPING CONTAINER TO PACKAGING AREA

7.12.1 If sample is in a lead pig or poly vial:

7.12.1.1 Tape top of container, twice around, with 1" Bron yellow tape.

7.12.2 Place container in the shipping area cave.

7.12.3 Remove gloves and dispose of in proper Hot Waste receptacle.

7.13 PREPARE TRANSFER CASK FOR REUSE

7.13.1 Clean transfer cask if required in preparation for future samples.

7.14 HOT LABORATORY CLEANUP

7.14.1 Put on fresh gloves.

7.14.2 Remove can from can opener.

7.14.3 Place removed can into "hot waste" storage area in hood.

7.14.4 Remove gloves and dispose of in proper Hot Waste receptacle.

7.14.5 Put on fresh gloves.

- 7.14.6 Decontaminate the following with masaline:
  - 7.14.6.1 Floor from end of table toward the hood,
  - 7.14.6.2 Hood handles and,
  - 7.14.6.3 Tools.
- 7.14.7 Wipe hood lid.
- 7.14.8 Swipe hood lip and floor in work area to check for contamination.
- 7.14.9 Use Hand, Foot Monitor for personal contamination check on way to reading swipes.
- 7.14.10 Read swipe to monitor for gross contamination.
- 7.14.11 If swipe indicates contamination: Repeat decontamination with masaline until further swiping indicates free of contamination.
  - 7.14.11.1 Floor from end of table toward the hood,
  - 7.14.11.2 Hood handles and,
  - 7.14.11.3 Tools.
- 7.14.12 Wipe hood lid.
- 7.14.13 Swipe hood lip and floor in work area to check for contamination.
- 7.14.14 Use Hand, Foot Monitor for personal contamination check on way to reading swipes.

7.15 COMPLETE PAPER WORK

- 7.15.1 The following paper work is transferred between Service Applications-Shipping and Service Applications-Isotopes:
- Sample Pull Sheet, Attachment 2.
  - Sample Sheet, Attachment 3.
  - Sample Shipment Information Sheet, Attachments 4.
- 7.15.2 Originally, the above paper work is generated by Service Applications-Isotopes and transferred to Service Applications-Shipping.
- 7.15.3 Prior to when the Shippers go to the hot cell the Sample Sheet is returned to Isotopes.
- 7.15.3.1 Isotopes enters the information of the Sample Sheet into the Data Base.
- 7.15.3.2 The Sample Sheet is returned to Shipping.
- 7.15.4 After the package is shipped the Documentation Packet, which includes, the Sample Sheet and Sample Shipment Information Sheet is returned to Isotopes where it remains until Billing.
- 7.15.4.1 The Sample Pull Sheet is filed by the Shipping Department.
- 7.15.5 After the Billing, the paper work is transferred to Service Applications Section Leader- Shipping.
- 7.15.6 The Service Applications Section Leader- Shipping:
- Files the paper work in numerical order and maintains this paper work for a period of three years.
  - Performs sampling of the documents for accuracy.
- 7.15.7 After a three year period, this paper work is sent to the University of Missouri Storage.

ATTACHMENTS

- A. Hot Laboratory Flow Chart, (Attachment 1).
- B. Sample Pull Sheet, (Attachment 2).
- C. Sample Sheet, (Attachment 3).
- D. Sample Shipment Information Sheet, (Attachment 4).

REFERENCES

A Health Physics Standard Operating Procedures:

- 1. HP-4: Handling Radioactive Material in MURR Pool.
- 2. HP-12: Transfer of Radioactive Material within MURR building.

Procedure Cover Sheet

MURR-SAS-00004      0      17 February 1993  
(Procedure)                      (Revision)                      (Date)

Shipment of Radioactive Materials  
(Procedure Title)

Prepared By V.W. Zagar  
(Signature)

Reviewed By Mac Carbon Ditschler  
(Signature)

Revision Summary

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SHIPMENT OF RADIOACTIVE MATERIAL

## 1.0 PURPOSE AND SCOPE

This Procedure provides instructions for the Packaging and Final Shipment as specified in Section 4.0 of this Procedure of Type A, non-waste radioactive materials received at Reactor Services for Shipment: To ensure Compliance with applicable Regulations of Code of Federal Regulations (CFR), 10 CFR, 49CFR and International Air Transport Association (IATA).

## 2.0 PRECAUTIONS AND LIMITATIONS

2.1 Each container or cask used for the Shipment of Radioactive Materials Shall be approved for use and shall conform to Department of Transportation (DOT) Specifications contained in 49CFR and International Air Transport Association (IATA).

2.1.1 Certificates of Compliance shall be maintained on file for each container or cask.

2.2 Applicable container specifications must be specified by purchase order.

2.2.1 Purchase orders must stipulate that all containers to be used for shipment of Radioactive Materials bear a marking or label to show conformance to the applicable Specification, e.g., TYPE A.

2.3 Prior to any shipment of Radioactive Material, it shall be determined that the consignee (receiver) is licensed to receive that material.

2.4 A package of Radioactive Material shall not be transported unless it is properly described, classed, marked, packaged and labeled.

2.5 If the Radioactive Material exceeds any of the applicable limits in of 49CFR or IATA Manual, the Reactor Services Engineer or designee must be notified immediately.

2.5.1 The Radioactive Material shall not leave MURR until the problem has been resolved.

2.6 Air freight shipments of "Excepted Quantities" and "Medical" Radioactive Materials may be consigned to Passenger Aircraft in accordance to 49CFR.

2.6.1 All other Radioactive Material shipments by Air shall be consigned to "Cargo Only" Air Transportation.

- 2.7 Air Freight Shipment quantity limits shall be in accordance with the Requirements of 49CFR and IATA Regulations.
- 2.8 The non-fixed contamination on any external surface of any package shall be kept as low as practical and, under normal conditions of transport, must not exceed the levels specified in 49CFR and IATA Regulations.
  - 2.8.1 The level of non-fixed Radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.
- 2.9 Radioactive Materials having other hazardous characteristics shall be allocated packing groups I, II, or III, as appropriate, by application of the grouping criteria in accordance with 49CFR and IATA Regulations.
- 2.10 Ensure that all beta-gamma dose rate survey equipment and meter stick calibration stickers have not passed the calibration due date prior to use.
- 2.11 The requirements for each package containing fissile material shall comply in accordance with 49CFR.

- 3.0 MATERIALS AND EQUIPMENT
- 3.1 Capintec Radioisotope Calibrator, CRC-5RH or equivalent.
- 3.2 Eberline, Model RM-19 or equivalent.
- 3.3 Eberline , Model BC-4 or equivalent.
- 3.4 Ion Chamber Survey meter.
- 3.5 Radioactive Placards meeting the requirements of 49CFR and IATA.
- 3.6 Labels:
  - 3.6.1 Radioactive White I
  - 3.6.2 Radioactive Yellow II
  - 3.6.3 Radioactive Yellow III
  - 3.6.4 Empty
  - 3.6.5 Cargo Aircraft Only
  - 3.6.6 Package orientation Label (This Way Up Arrows)
  - 3.6.7 Subsidiary risks labels
  - 3.6.8 MURR Models labels
- 3.7 Smear papers
- 3.8 Cask handling tools and equipment
- 3.9 Seals
- 3.10 Shipping papers:
  - 3.10.1 Air freight
  - 3.10.2 Ground freight
- 3.11 Calibrated meter stick

- 3.12 DOT- 12B40 boxes with the following information:
- 3.12.1 Label:  
USA DOT Type A  
Radioactive Material  
Specification Certified by  
University of Missouri  
Research Reactor  
Columbia, Mo. 65211
- 3.12.2 Label:  
RADIOACTIVE MATERIAL  
N.O.S. UN2982
- 3.13 Expanded Polystyrene packing for 40-UN151313 box
- 3.14 Ellisco Tear strip bright tinplate can to accept " Shipping Pig"  
/ container (can) marked with Radioactive (yellow/magenta)  
tape.
- 4.0 DEFINITIONS:
- 4.1 A1: The maximum activity of " SPECIAL FORM" Radioactive  
material permitted in a Type A package.
- 4.1.1 Values of A1 for most Radionuclides are given in 49CFR and  
IATA Regulations.
- 4.2 A2: The maximum activity of Radioactive material, other than  
"Special Form" Radioactive material, permitted in type A  
package.
- 4.2.1 Values of A2 for most Radionuclides are given in Tables of  
49CFR and IATA Regulations.
- 4.3 Becquerel (Bq): Is the standard unit of measure for the  
Radioactivity of a Radionuclide used in IATA, Dangerous Goods  
Regulations. One Bq equals one decay per second.
- 4.3.1 Gigabecquerel (GBq): One GBq = 1,000,000,000 Bq or  $1E^9$  Bq.
- 4.3.2 Terabecquerel (TBq): One TBq = 1,000,000,000,000 Bq or  
 $1E^{12}$  Bq.
- 4.3.3 The Bq replaces the older unit for activity, the Curie (Ci).
- 4.3.3.1 One Ci is equal to 37 GBq.

4.4 Conversion Factors: Table shows conversion factors to four significant figures.

| 4.4.1 | To convert | To  | Multiply by: |
|-------|------------|-----|--------------|
|       | Ci         | GBq | 37.00        |
|       | TBq        | Ci  | 27.03        |

4.5 External Contamination: Is the non-fixed Radioactive contamination on any external surface of any package. It shall be kept as low as practical and, under normal conditions of transport, shall not exceed the levels specified in 49CFR and IATA Regulations.

4.6 Fissile material: means any material consisting of or containing one or more fissile Radionuclides. Fissile materials are plutonium-238, plutonium-239, plutonium-241, uranium-233, and uranium-235. Neither natural nor depleted uranium are fissile material. Fissile materials are classified according to the controls to provide nuclear criticality safety during transportation, as provided in 49CFR.

4.7 Low specific activity material (LSA) means any of the following:

- 4.7.1 Uranium or thorium ores and physical or chemical concentrates of those ores.
- 4.7.2 Unirradiated natural or depleted uranium or unirradiated natural thorium.
- 4.7.3 Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.
- 4.7.4 Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration of contents does not exceed:
  - 4.7.4.1 0.0001 millicurie per gram of Radionuclides for which the A2 quantity is not more than .05 curie;
  - 4.7.4.2 0.005 millicurie per gram of Radionuclides for which the A2 is more than .05 curie, but not more than 1 curie; or
  - 4.7.4.3 0.3 millicurie per gram of Radionuclides for which the A2 quantity is more than 1 curie.

- 4.7.5 Objects of non-radioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegration's per minute) per square centimeter of Radionuclides for which the A2 quantity is not more than .05 curie, or 0.001 millicurie (2,200,000 disintegration's per minute) per square centimeter for other Radionuclides.
- 4.8 Non-fixed Radioactive Material: Radioactive contamination that can be removed from a surface by wiping with a dry smear.
- 4.9 Normal Form Radioactive Material: Radioactive Material which has not been Qualified as " Special Form" Radioactive Material.
- 4.10 Shipping Technician (Shipper) is defined to be any person in the Shipping Group:
- 4.10.1 Shipper, Trainee: Can neither Perform or Inspect a Task.
- 4.10.2 Shipper, Qualified: Is an individual who has completed the Required Documented Training to perform a specific Task.
- 4.10.3 Shipper, Certified: Is Qualified to perform all aspects of Shipping as documented by Training.
- 4.11 Special Form Radioactive Material: Radioactive Material is either an in-dispersible solid Radioactive Material or a sealed capsule containing Radioactive Material.
- 4.11.1 Special Form Radioactive Material shall meet the requirements of 49CFR and IATA regulations.
- 4.11.1.1 If it is in a sealed capsule, that capsule shall be so constructed that it can only be opened by destroying.
- 4.11.1.2 The Special Form Radioactive Material shall have at least one dimension not less than 5 mm.
- 4.11.1.3 The Special Form design shall have received unilateral approval.

- 4.12 Shall, Must, Should
- 4.12.1 Shall : Regulatory Commitment to Code of Federal Regulations, 10CFR, 49CFR and IATA Dangerous Goods Regulations.
- 4.12.2 Must : MURR Internal Commitment to 10CFR, 49CFR and IATA Regulations.
- 4.12.3 Should: Recommended; not required.
- 4.13 Specific Activity: The Activity of the Radionuclide per unit mass of that nuclide.
- 4.14 Transport Index Number (TI), Radioactive Material Only: The dimensionless number (rounded up to the first decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation.
- 4.14.1 The TI number is determined in accordance 49CFR and IATA Regulations.
- 4.14.2 The transport index is determined as follows:
- 4.14.2.1 The number expressing the maximum radiation level in millirem per hour at one meter (3.3 feet) from the external surface of the packaging; or
- 4.14.2.2 For fissile class II packages or packages in a fissile III shipment, the number expressing the maximum radiation level at one meter (3.3 feet) from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages, which may be transported together, whichever is larger.
- 4.15 Type A Packaging: A type "A" package shall not contain activities greater than the following:
- 4.15.1 For "Special Form" Radioactive Material the value of A1 is listed in Tables of 49CFR and IATA Regulations.
- 4.15.2 For other Radioactive Material the value of A2 is listed in Tables of 49CFR and IATA Regulations.
- 4.16 Type B Packaging: The only limits on the activities contained in type B packages are those prescribed on their approval certificates in accordance with the Code of Federal Regulations, 10CFR and 49CFR.

- 4.17 Primary Hazard Label: Identifies governing hazard for a package. Radioactivity is normally the governing hazard for packages shipped by MURR. Radioactive material shall be labeled in accordance with the guidelines of the following categories:
- 4.17.1 White I = The maximum radiation level at any point on the external surface is 0.5 mrem/hr. The Transport Index is not applicable.
- 4.17.2 Yellow II = The maximum radiation level on any point on the external surface is more than 0.5 mrem/hr but not more than 50 mrem/hr. The Transport Index is more than 0 but not more than 1.
- 4.17.3 Yellow III = The maximum radiation level at any point on the external surface is more than 50 mrem/hr. but not more than 200 mrem/hr. The Transport Index is more than 1 but not more than 10.
- 4.17.3.1 Packages with contact dose rates greater than 200 mrem/hr or with a TI greater than 10 shall be shipped as an Exclusive Use Shipment.
- 4.17.4 Packages and overpacks shall be assigned to Category White I, Yellow II, or Yellow III in accordance with 49CFR and IATA Dangerous Goods Regulations.
- 4.17.5 Shipper's Declaration for Dangerous Goods: Will be completed for each and every shipment containing Dangerous Goods so defined or Classified in 49CFR and IATA, unless it is stated that one is not required (Limited Quantities).

4.18 PACKAGING PROCEDURE USED FOR TEST CERTIFICATION OF USA DOT MURR Model 1000 Shipping Container.

4.18.1 Authorized contents for package identification of MURR 1000 is Solid Normal Form Type A Radioactive Material.

4.18.2 Description of package:

- Sample is shielded by a MURR lead pig No. 1288 with hole diameter between 0.5" and 3".
- MURR lead pig is sealed with Bron 1 " yellow vinyl tape.
- The primary containment is an Ellisco round tearstrip bright tinplate 404 x 7" can.
- Ellisco can is inserted in two expanded polystyrene # 1 density modified bead packing inserts (MURR dwg No. 1100) with Wunderlich 15.5" x 13.5" x 0.188 " fiberboard endcaps.
- The polystyrene is strapped with Miller-Bevco 9 mm strapping # 06MG0912998WH.
- The polystyrene is inserted in a Wunderlich box # 151313.
- The Wunderlich box is sealed with 3" Scotch brand tape type 3M-355.

4.18.3 Packaging Procedure:

- Sample is placed in the lead pig.
- The lead pig is sealed by Bron 1" yellow tape.
- The lead pig is sealed in the Ellisco can.
- The Ellisco can is placed in two expanded polystyrene # 1 packing inserts with fiberboard endcaps.
- The polystyrene is secured by four crossing Miller-Bevco 9 mm straps.
- The strapped polystyrene is placed in the Wunderlich fiberboard box.
- The box is secured by applying 3" Scotch brand tape type 3M-355 to all seams.

4.19 PACKAGING PROCEDURE USED FOR TEST CERTIFICATION OF USA DOT MURR Model 1100 Shipping Container

4.19.1 The authorized contents for package identification of MURR 1100 is Solid and Liquid Normal Form Type A Radioactive Material.

4.19.2 Description of Package:

- Sample contained in a Secondary containment.
- Secondary containment is sealed by Bron 1" yellow vinyl tape or crimp seal.
- Kimpak # 64290-00 is used to absorb twice the liquid contained.
- Shielding is a MURR lead pig # 1288 with a hole diameter between 1.25" and 3.0".
- MURR lead pig # 1288 is sealed with Bron 1" yellow vinyl tape.
- The primary containment is an Ellisco round tearstrip bright tinplate 404 x 7" can.
- Ellisco can is inserted in two expanded polystyrene # 2 density modified bead packing inserts (MURR dwg. # 1180) with Wunderlich 15.5" x 13.5" x 0.188" fiberboard endcaps.
- The polystyrene is strapped with Miller-Bevco 9 mm strapping # 06MG0912998WH.
- The polystyrene is inserted in a Wunderlich box #40UN151313.
- The Wunderlich box is sealed with 3" Scotch brand tape type 3M-355.

## 4.19.3 Packaging Procedure:

- Sample is placed in secondary containment.
- The secondary containment is sealed by Bron 1" or crimp seal.
- The secondary containment is placed in the lead pig with sufficient Kimpak to absorb twice the liquid contained in the sample.
- The lead pig is sealed by Bron 1" yellow tape.
- The lead pig is sealed in the Ellisco can.
- The Ellisco can is placed in two expanded polystyrene # 2 packing inserts with fiberboard endcaps.
- The polystyrene is secured by four crossing Miller-Bevco 9 mm straps.
- The strapped polystyrene is placed in the Wunderlich fiberboard box.
- The box is secured by applying 3" Scotch tape type 3M-355 to all seams.

4.20 PACKAGING PROCEDURE USED FOR TEST CERTIFICATION OF USA DOT MURR Model 1220 Shipping Container.

4.20.1 The authorized contents for package identification of MURR 1220 is Solid and Liquid Form Type A Radioactive Material.

4.20.2 Description of Package:

- Sample contained in secondary containment.
- Secondary containment is sealed by Bron 1" yellow vinyl tape or crimp seal.
- Shielding is a Mallinckrodt Screw Top white shipping pig No. 2.
- The Mallinckrodt shipping pig No. 2 is sealed by Bron 1" yellow vinyl tape.
- Kimpak No. 64290-00 is used to absorb at twice the liquid contained.
- The primary containment is an Elisco round tearstrip bright tinplate 404 x 7" can.
- Elisco can is inserted in two expanded polystyrene # 1 density modified bead packing inserts (MURR dwg No. 1180) with Wunderlich 15.5" x 13.5" x 0.188" fiberboard endcaps.
- The polystyrene is strapped with Miller-Bevco 9 mm strapping # 06MG0912998WH.
- The polystyrene is inserted in a Wunderlich box # UN151313.
- The wunderlich box is sealed with 3" Scotch brand tape type 3M-355.

## 4.20.3 Packaging Procedure:

- Sample is placed in secondary containment.
- The secondary containment is sealed by Bron 1" yellow tape or crimp seal.
- The secondary containment is placed in the Mallinckrodt lead pig.
- The lead pig is sealed by Bron 1" yellow tape.
- The lead pig is sealed in the Ellisco can with sufficient Kimpack to absorb twice the liquid contained.
- The Ellisco can is placed in two expanded polystyrene #1 packing inserts with fiberboard endcaps.
- The polystyrene is secured by four crossing Miller- Bevco 9 mm straps.
- The strapped polystyrene is placed in the Wunderlich fiberboard box.
- The box is secured by applying 3" Scotch brand tape Type 3M- 355 to all seams.

4.21 PACKAGING PROCEDURE USED FOR TEST CERTIFICATION OF USA DOT MURR Model 1300 Shipping Container.

4.21.1 The authorized contents for package identification of MURR 1300 is Solid and Liquid Normal Form Type A Radioactive Material.

4.21.2 Description of Package:

- Sample contained in secondary containment.
- Secondary containment is sealed by Bron 1" yellow vinyl tape or crimp seal.
- There is no lead shielding.
- Kimpak = 64290-00 is used to absorb twice the liquid contained.
- The primary containment is an Ellisco round tearstrip bright tinplate 404 x 7" can.
- Ellisco can is inserted in two expanded polystyrene # 1 density modified bead packing inserts (MURR dwg No. 1180) with Wunderlich 15.5" x 13.5" x 0.188" fiberboard endcaps.
- The polystyrene is strapped with Miller-Bevco 9 mm strapping # 06MGO912998WH.
- The polystyrene is inserted in Wunderlich box # UN151313.
- The Wunderlich box is sealed with 3" Scotch brand tape type 3M-355.

## 4.21.3 Packaging Procedure:

- Sample is placed in secondary containment.
- The secondary containment is sealed by Bron 1" yellow tape or crimp seal.
- The secondary containment is sealed in the Ellisco can with sufficient Kimpak to absorb twice the liquid contained.
- The Ellisco can is placed in two expanded polystyrene #1 packing inserts with fiberboard endcaps.
- The polystyrene is secured by four crossing Miller-Bevco 9mm straps.
- The strapped polystyrene is placed in the Wunderlich fiberboard box.
- The box is secured by applying 3" Scotch brand tape type 3M-355 to all seams

5.0 RESPONSIBILITIES

5.1 Reactor Services Engineer: Ensure that all shipments of Radioactive Material conform to applicable Regulations of 10CFR, 49CFR, and IATA. Provide properly certified packages for shipment of Radioactive Materials.

5.2 Health Physics Manger: Provide Health Physics (H.P.) support as required to Service Applications Group for preparation of Radioactive Material Shipments.

5.3 Reactor Operations Manager: Provide around the clock Emergency Response Information concerning Radioactive Material shipments from MURR.

5.3.1 Emergency Response Information Required by Operations Control Room Operators:

- Shipment Destination
- Shipment Isotope
- Shipment Activity
- MURR Shipment I.D. Number
- Emergency Call List.

- 6.0 PROCEDURE
- 6.1 Ensure that Consignees (Receivers) of MURR Shipments of Radioactive Materials are properly authorized to receive the Type, Form, and Quantity of such material in accordance with Provisions of 10CFR.
- 6.2 Ensure that proper shipping classification (i.e.) Type "A" or B, Packaging, Shipping Papers, Marking, Labeling, and Placarding are identified and maintained as the preparation for shipping proceeds.
- 6.3 The following unique characteristics of each shipment must be maintained throughout Receipt, Safety Analysis, Preparation for Irradiation, Irradiation, Post Irradiation Processing, Packaging, and Shipment:
- 6.3.1 Material Description
- 6.3.2 Amount (Mass)
- 6.3.3 Isotopes
- 6.3.4 Activity
- 6.3.5 Destination
- 6.3.6 MURR ID Number
- 6.3.7 License Number, Amendment Number and Expiration Date or DOE authorization or Certification as specified in 10CFR.
- 6.4 All shipments shall conform with Provisions of 49CFR, 10CFR and IATA, Dangerous Goods Regulations.
- 6.5 Packaging performance and environmental testing or evaluation for type A Packaging used for radioactive shipments Shall meet DOT 7A Requirements.
- 6.5.1 Such testing or evaluation shall be documented and maintained on file.
- 6.6 Type B Packaging Shall meet the Requirements of MURR Quality Assurance (QA) program for shipping as required by 10CFR.

- 6.7 Data Integrity will be maintained by Documented Control Check Sheets for USA DOT MURR models 1000,1100, 1220, and 1300 shipping containers with Independent Verification at critical points in the shipping process. (Pages 1 through 4, Attachment 4.)
- 6.7.1 The "Performer" of a Shipping Process and "Independent Redundant Verifier" must not be the same individual.
- 6.7.2 The Independent Verifier must also be a Qualified Shipper for that task.
- 6.8 MURR Shipping Personnel involved in any Task within the scope of this Procedure will receive Documented Initial and Annual Refresher Training applicable to that task of shipping Radioactive Material in accordance with 49CFR - Training.
- 7.0 PACKAGING FLOW CHART, TYPE A
- 7.0.1 The Packaging Flow Chart (Attachment 1) involves series and parallel steps labeled in accordance with the Procedure steps.
- 7.0.2 Series steps of the flow chart must be accomplished in sequential order.
- 7.0.3 Parallel steps of the flow chart may be accomplished in sequential order or at the same time, whichever is the most efficient.
- 7.1 QUALIFIED SHIPPER CHECK-IN
- The Qualified Shipper performs the Verification that the Shipping Container and Shipping Request agree and perform the following:
- 7.1.1 Verification that "In-house Radioactive Shipping Request Form" (Attachment 2) matches data on the shipping container by completing item 4 prior to acceptance of Radioactive Material.
- 7.1.2 Verification that "Request for Radioisotope Shipment Form" (Attachment 3) matches the "In-house Radioactive Shipping Request Form" (Attachment 2) by comparing the data and completing Item 5 of the In-house Radioactive Shipping Request Form (Attachment 2)
- 7.1.3 Place the "Shipping Container," containing the Radioisotope into the Shielded Storage.
- 7.1.4 Staple "Customer Request for Radioisotope Shipment" and "In-house Radioactive Shipping Request" forms together and place into the Receipt "In-box".

7.2 RECEIPT " IN-BOX"

7.2.1 A Qualified Shipper will process Check-in paperwork.

7.3 PREPARE PACKAGE PACKETA Qualified Shipper will prepare the Package Packet:

7.3.1 Determine the proper Shipping Container based on information from Sections 4.18, 4.19, 4.20 or 4.21 (Attachment 4).

7.3.2 Prepare labels:

7.3.2.1 Two each: MURR package Model Number, e.g., MURR 1000, etc.

7.3.2.2 Six each: Shipping Label with Shipment Destination, Isotope, MURR ID number, and Activity.

7.3.2.3 Two each: USA DOT 7A Type A  
Radioactive Material  
Specification Certified by  
University of Missouri  
Research Reactor  
Columbia, Mo. 652117.3.2.3 Two each: RADIOACTIVE MATERIAL  
N.O.S. UN29827.3.3 Prepare "Control Check Sheet" for proper USA DOT MURR Model Number Package, Model 1000,1100,1220, or 1300. (Attachment 4).7.3.4 Place the prepared Package Packet in the Package Packet "In-Box".7.4 PACKAGE PACKET "IN-BOX"Qualified Shipper will remove Package Packet from Package Packet " In-Box "

7.5 PACKAGE PREPARATION

Qualified Shipper must prepare the package in accordance with the enclosed Control Check Sheet (Attachment 4).

*NOTE: Only one box must be in the immediate work area and packaging must be accomplished in a clear work area with no other packages (package components) within five feet.*

The Control Check Sheet must be used as verification of Performer's activities completed and Inspector's Independent Verification of same by initialing the steps required.

*Initials are to be entered after steps marked (\*) are completed.*

- 7.5.1 Ensure accuracy of label on Control Check Sheet (Attachment 4) as to shipment destination, isotope, MURR I.D number, and activity: steps one through four. Ensure that all labels contain the same information.
- 7.5.2 Identify and install label with shipment destination, isotope, MURR ID number and activity on the lid of the Shipping Can.
- 7.5.3 Identify and install label with shipment destination, isotope, MURR ID number and activity on side 1 (top outside flap) of the 7A container.
- 7.5.4 Identify and install label with shipment destination, isotope, MURR ID number and activity to the top of the polystyrene insert.
- 7.5.5 Ensure Control Check Sheet (Attachment 4) agrees with the two labels indicating MURR Model Number and place labels on type 7A container directly under certification labels.
- 7.5.6 \*Ensure lead shipping container and inner shipping can identification labels agree.
- 7.5.7 \* Seal inner shipping can with sealing machine.
- 7.5.8 \* Verify radioactive labels are on inner can.
- 7.5.9 Insert inner shipping can into polystyrene.
- 7.5.10 \*Place polystyrene top with identifying label over shipping can.

- 7.5.11 Strap polystyrene insert by strapping machine with:
  - 7.5.11.1 Two straps centered over polystyrene cardboard cover.
  - 7.5.11.2 Rotate polystyrene ninety degrees.
  - 7.5.11.3 \*Apply two additional straps centered over polystyrene cardboard cover.
- 7.5.12 Insert polystyrene into type 7A container with Identification Label on top for viewing when container flaps are opened.
- 7.5.13 Tape inner flap at least 75 percent of length.
- 7.5.14 Tape loose edges of container with three inch clear tape with a minimum of two inches down on the sides of 7A container.
- 7.5.15 \*Use the strapping machine to strap each container approximately two inches from both sides and ninety degrees with respect to container center flaps over sides 1 and 3.
- 7.5.16 \*Install security labels on the center edge of container on top and bottom.
- 7.5.17 \*Ensure Certification label is on the 7A container.
- 7.5.18 \*Ensure proper shipping name and UN number label is on 7A container.
- 7.5.19 Number type 7A container sides 1, 2, 3, 4.
- 7.5.20 Identify swipe (filter paper, 4.25 cm diameter) with:
  - 7.5.20.1 Shipment MURR I.D. number.
  - 7.5.20.2 Abbreviated customer name.
- 7.5.21 Swipe four sides, top and bottom of 7A container.
- 7.5.22 Ensure no contamination ( greater than 20 dpm per 300 cm<sup>2</sup> ) exists on outside of container by reading swipe on swipe counter.
- 7.5.23 The dose rate (mrem/hr) must be measured at contact of the external surface of the containers' four numbered sides, top and bottom.
  - 7.5.23.1 Obtained readings must be recorded on the control check sheet by performer and independently verified by inspector.

7.5.24 The transport index (TI) dose rate (mrem/hr) shall be measured at a distance of one meter from the package face with the maximum contact reading.

7.5.24.1 \*Obtained reading must be recorded on the control sheet by performer and independently verified by inspector.

7.6 PACKAGE PLACED IN STORAGE

*NOTE: POST AREA WITH DOSE RATE TO WARN OTHER WORKERS IN THE AREA.*

7.6.1 The package is placed in storage awaiting the completed Shipping Papers from Final Packaging Checkout "In-box".

7.6.2 The applicable Control Check Sheet, (Attachment 4) is placed in the Documentation Packet "In-box".

7.7 PREPARE SHIPPING PAPERS

7.7.1 A Qualified Shipper will process paperwork from Receipt "In-box".

7.7.2 A Qualified Shipper will:

7.7.2.1 Determine proper Carrier routing.

7.7.2.2 Prepare the Address Label (attachment 5 )

7.7.2.3 Prepare the Material Transfer Form (attachment 6 )

7.7.2.4 Prepare the Shippers Declaration Form (attachment 7)

7.7.3 Place all of the above in a packet and put into the Documentation Packet "In-box". (This material is defined as the Documentation Packet)

7.8 DOCUMENTATION PACKET "IN-BOX"

7.8.1 The Documentation Packet and the Package Packet are combined in the Documentation Packet "In-box".

7.9 SHIPPING PAPER PACKET "IN-BOX"

7.9.1 The Package Packet is combined with the Documentation Packet to form the Shipping Paper Packet.

7.9.2 The Shipping Paper Packet is then placed into Shipping Paper Packet "In-Box" where it remains until a Certified Shipper is ready to complete the documentation.

- 7.10 COMPLETE SHIPPING PAPERS
- 7.10.1 A Certified Shipper will complete shipping papers obtained from Shipping Paper Packet "In-Box" and perform the following:
- 7.10.1.1 Determine the proper radioactive label White I, Yellow II, or Yellow III in accordance with 49CFR, or IATA Regulations.
- 7.10.1.2 Fill out the radioactive label.
- 7.10.1.3 Determine the label(s) required for subsidiary risk by use of Label Specifications) of IATA Dangerous Goods Regulations.
- 7.10.1.4 Provide label(s) for subsidiary risk(s).
- 7.10.1.5 Determine other hazardous label(s) required by use of Section 7.3 of IATA Dangerous Goods Regulations.
- 7.10.1.6 Add transport index to shipping papers, category of radioactive label (White I, Yellow II, Yellow III), and Subsidiary Risks labels from the Control Check Sheet.
- 7.10.1.7 Add swipe information to shipping papers.
- 7.10.2 Complete the appropriate documentation section of the Control Check Sheet.
- 7.10.3 Ensure Information specified on the In-House Radioactive Shipping Request Form (Attachment 2) or the Request for Radioisotope Shipment Form (Attachment 3) is within the license restrictions:
- 7.10.3.1 \*License number, amendment number and expiration date agree.
- 7.10.3.2 \*Isotope and activity is within acceptable limits and possession limits.
- 7.10.3.3 \*The shipping address is correct.
- 7.10.3.4 \*Transfer Form is in packing enclosure.
- 7.10.3.5 \*Ensure that Shipment Waybill(s), address label, container identification agree.
- 7.10.4 Place completed shipping papers in the Final Packaging Checkout "In-Box".

7.11 FINAL PACKAGING CHECKOUT "IN-BOX"

7.11.1 Package is ready for final attachment of labels and checkout.

7.12 FINAL PACKAGING

A Qualified Shipper will locate the specific Package Packet in the Final Packaging Checkout "In-Box".

## 7.12.1 Perform the following for Air Freight:

7.12.1.1 Affix address.

7.12.1.2 Affix packing list envelope.

7.12.1.3 Affix Shippers Declaration (Attachment 7a).

7.12.1.4 Affix appropriate Primary Hazard label:  
White I, Yellow II, or Yellow III.

7.12.1.5 Affix subsidiary risk(s) label.

7.12.1.6 Affix "Cargo Aircraft Only" label.

# Exception for passenger aircraft is for medical use and if TI is equal to or less than 3.0.

7.12.1.7 Affix "This Way Up" arrow, if appropriate.

7.12.1.8 Certified Shipper signs and dates Control Check Sheet (Attachment 4).

## 7.12.2 Perform the following for Ground Freight:

7.12.2.1 Affix address.

7.12.2.2 Affix Straight Bill of Lading (Attachment 7b).

7.12.2.3 Affix packing list.

7.12.2.4 Affix appropriate Primary Hazard label: White I Yellow II, or Yellow III.

7.12.2.5 Affix Subsidiary Risk Label.

7.12.3 Certified Shipper signs and dates Control Check Sheet (attachment 4).

7.13 FINAL VERIFICATION "IN-BOX"

- 7.13.1 Package is ready for final verification by Health Physics (H.P.)
- 7.13.2 Notify H.P. independent verification is required.

7.14 FINAL VERIFICATION

- 7.14.1 Will be conducted by an assigned Health Physics Personnel to verify:
  - 7.14.1.1 Isotope and activity is within acceptable limits and possession limits as listed on Shipping Summary Form (Attachment 8).
  - 7.14.1.2 Ensure that waybill(s), address label, container identification agree.
- 7.14.2 Ensure following labels are affixed :
  - 7.14.2.1 Address
  - 7.14.2.2 Appropriate White I, Yellow II or Yellow III.
  - 7.14.2.3 Verify Reportable Quantity.
  - 7.14.2.4 Subsidiary risk(s).
  - 7.14.2.5 Cargo Aircraft Only.
  - 7.14.2.6 "This Way Up" arrow.
  - 7.14.2.7 Verify Transport Index and Activity.

7.15 SHIPPING SUMMARY FORM

The Shipping Summary Form (Attachment 8) is used for Quality Control as a final review of the package and Shipper's Declaration before releasing the package to the courier.

The Shipping Summary Form is prepared by the Shipping Section Leader or authorized individual. It is prepared by use of independent projected shipping schedules and the Sample Folders.

Once prepared, a Qualified Shipper will review the information for accuracy after which, will initial each line.

7.16 RELEASE TO COURIER

Package is picked up and signed for by a Courier only if the package is a yellow III.

7.17 EMERGENCY RESPONSE INFORMATION

A copy of the Dangerous Goods Declaration is placed in the Control Room Emergency Response Book.

7.18 NOTIFICATION OF A SHIPMENT

Notification of a shipment may take place anytime after the package has been signed-off by a Certified Shipper.

7.18.1 Notification of the radioactive shipment should be made by a Qualified Shipper using Telephone calls, Fax or Mail.

7.18.2 The Control Check Sheet (attachment 4 ) should be initialed and method of notification noted.

## REFERENCES

- A. Federal Code of Regulations 49CFR.
- B. Federal Code of Regulations 10CFR.
- C. International Air Transport Association Dangerous Goods Regulations.
- D. Packaging Flow Chart (Attachment 1).
- E. In- House Radioactive Shipping Request Form (Attachment 2).
- F. Request for Radioisotope Shipment Form (Attachment 3).
- G. Control Check Sheets for USA DOT MURR Models (Attachment 4).
- H. Address Label Examples (Attachment 5).
- I. Material Transfer Form (Attachment 6).
- J. Shippers Declaration For Dangerous Goods Form (Attachment 7a).
- K. Straight Bill of lading (Attachment 7b).
- L. Shipping Summary Form (Attachment 8).

Procedure Cover Sheet

MURR-SAS-00005  
(Procedure)

0  
(Revision)

17 May 1993  
(Date)

Hot Cell Loading of Host Cans  
(Procedure Title)

Prepared By V.W. Zager  
(Signature)

Reviewed By Mac Charles Gieseler  
(Signature)

Revision Summary

| <u>Rev. #</u> | <u>Date</u> | <u>Significant</u> | <u>Summary</u> |
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1.0 PURPOSE AND SCOPE

This procedure provides instructions for hot cell loading of host cans to be irradiated in the Reactor Flux Trap.

The purpose is to ensure Compliance with applicable Regulations of Code of Federal Regulations (CFR), 10CFR, 49CFR and International Air Transport Association (IATA).

- 1.1 This activity is scheduled during the normal "shutdown" periods of the reactor and is completed prior to "startup" of the reactor.
- 1.2 This operation of loading a host can for irradiation starts after the previously irradiated capsules have been removed from the transfer cask and/or removed from storage in the hot cell as depicted in the Procedure MURR-SAS-00002, Hot Cell Preparation of Radioactive Material for Shipment. New capsule(s) may also be inserted into the host can.
- 1.3 This procedure incorporates:
- Positive identification of host can(s),
  - Positive identification of capsule(s) removed from an opened host can, capsule(s) from hot cell storage or new capsule(s),
  - Reloading capsule(s) into a different host can,
  - Loading new capsules in a host can,
  - Placement and welding of lid on the new host can and,
  - Testing performed on the host can after welding to ensure correct size and water tight integrity.
- 1.4 This Procedure duplicates some Steps of MURR-SAS-00002.
- 1.5 Specific details are used as examples in this Procedure to illustrate the process flow, i.e., using the host can numbers, etc. of the Attachments.

- 2.0 PRECAUTIONS AND LIMITATIONS
- 2.1 The non-fixed contamination on any external surface of the transfer cask must be kept as low as practical.
- 2.1.1 The level of non-fixed radioactive contamination may be determined by wiping an area of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material.
- 2.2 Ensure that all beta-gamma dose rate survey, contamination counting, and gamma radioisotope equipment calibration stickers have not passed the calibration due date prior to use.
- 2.3 Ensure that upon leaving the hot cell area you measure for personal external contamination by use of the Hand-foot monitor or equivalent device.
- 2.3.1 When the Hand-foot monitor alarms indicating external contamination, call Health Physics immediately at extension #2-5217.
- 2.3.2 After 5:00 P.M. or Weekends call the Control Room at extension # 2-5213.
- 2.4 Maintain radiation exposure As Low As Reasonably Achievable (ALARA) by use of Time, Distance, and Shielding.
- 2.5 Use protective clothing:
- Laboratory Coats
  - Rubber/Latex Gloves
  - Safety glasses and/or Face Shield.
- 2.6 In the event of a stuck capsule or broken vial, the Reactor Services Engineer or Designee must be notified immediately.

- 3.0 MATERIALS AND EQUIPMENT
- 3.1 Calibrated gross contamination counting equipment.
- 3.2 Calibrated Beta counter.
- 3.3 Smear papers.
- 3.4 Cask handling tools and equipment.
- 3.5 Protective clothing, to include:
  - 3.5.1 Rubber/latex gloves.
  - 3.5.2 Laboratory coats.
  - 3.5.3 Safety glasses and/or face shield.
- 3.6 Loading of radioactive material chart, Attachment 1.
- 3.7 Sample Pull Sheet, Attachment 2.
- 3.8 Sample Shipment Information Sheet, Attachments 4 and 6.
- 3.9 Existing Loading Sheets, Attachments 5 and 7.
- 3.10 Welding unit, Miller 330A/BP or equivalent.
- 3.11 Tec Torch Model 308 or equivalent.

- 4.0 DEFINITIONS
- 4.1 Activity: Is a measure of the quantity of radioactivity emitted by a radioisotope and is used to determine the amount of radioactive material which may be transported in various types of packaging.
- 4.2 Host Can: Is a multi-carrier of capsules, with spacers, if required, which may contain capsules from:
- Prior Host cans previously irradiated,
  - Storage which have been previously irradiated and placed in Storage or,
  - New capsules to be irradiated.
- 4.3 Host Capsule Change Sheet: This term is used in the Description Section of the Sample Shipment Information Sheet (Attachments 4 and 6). It is an interchangeable title for the Existing Loading Sheet (Attachments 5 and 7).
- 4.4 Observer: An Independent Verifier who observes critical points of the processing steps and documents the performance of these steps by legibly initialing the steps as they are performed.
- 4.5 Performer: The individual who performs the critical step of the process and documents the performance of these steps by legibly initialing the steps as they are performed.
- 4.6 Radioactive Contents: The radioactive material together with any contaminated solids, liquids and gases within the package.
- 4.7 Radioactive material: Any material having a specific activity greater than 0.002 micro curies per gram (uCi/g).
- 4.8 Shall, Must, Should:
- 4.8.1 Shall: Regulatory Commitment to Code of Regulations, 10CFR, 49CFR and IATA Dangerous Goods Regulations.
- 4.8.2 Must: MURR Internal Commitment to 10CFR, 49CFR and IATA Regulations.
- 4.8.3 Should: Should be accomplished; not required.

- 4.9      Spacer: Used to take up space in the host can to minimize capsule movement.
- 4.10     Specific Activity: The activity of the radionuclide per unit weight of that nuclide.
- 4.11     Transfer Cask: Used to transport samples within the facility.

5.0 RESPONSIBILITIES

- 5.1 Reactor Services Engineer: Ensure that all host cans loaded for insertion into the reactor are prepared in accordance with Reactor Technical Specifications, Reactor Utilization Request (RUR) Control Sheet and appropriate Procedures.
- 5.2 Health Physics Manager: Provide Health Physics (HP) support as required to Service Applications Group for preparation of radioactive material shipments.
- 5.3 Reactor Operations Manager: Ensure that all host cans loaded for insertion into the reactor are prepared in accordance with Reactor Technical Specifications, RUR's and appropriate Procedures.

6.0 PROCEDURE

- 6.1 Ensure that host cans are prepared in accordance with Reactor Technical Specifications, RUR's and appropriate Procedures.
- 6.2 The following unique characteristics of each shipment shall be maintained throughout Receipt, Safety Analysis, Preparation for Irradiation, Irradiation, Post Irradiation Processing, Packaging, and Documentation:
- 6.2.1 Material Description,
  - 6.2.2 Amount (Mass),
  - 6.2.3 Isotopes,
  - 6.2.4 Activity,
  - 6.2.5 Destination,
  - 6.2.6 Recipient's License Number, Amendment Number and Expiration Date or certificate in accordance with 10CFR.
  - 6.2.7 MURR Identification Number.

- 6.3 Data integrity must be maintained by documented Control Check sheets with Independent Verification at critical points in the process.
- 6.3.1 The "Performer" of a shipping process and "Observer" must not be the same individual.
- 6.3.2 The Observer must also be Qualified to perform the Task.
- 7.0 HOT CELL LOADING OF HOST CANS
- 7.0.1 The Loading of Radioactive Material Flow Chart (Attachment 1) involves series and parallel steps labeled in accordance with the Procedure step numbers and must be adhered to by the Shipping Department Personnel unless otherwise noted.
- 7.0.2 Series steps of the flow chart must be accomplished in sequential order.
- 7.0.3 Some parallel steps are alternative parallel steps of the flow chart and may be accomplished in sequential order or at the same time, whichever is the most efficient.
- 7.0.4 Processing of the radioisotopes prior to packaging for shipment is accomplished in cooperation with MURR Operations (OPS), Health Physics (HP) and Service Applications (SA) Departments.
- 7.0.5 The Sample Pull Sheet (Attachment 2) designates the host can(s) by their can numbers and provides instructions for the movements of specific capsules.
- 7.0.6 The Sample Shipment Information Sheet (Attachments 4 and 6) used for loading are differentiated from other Sample Shipment Information Sheets by being identified with a pink edge around the sheet or copied on different colored paper.
- 7.0.7 The Existing Loading Sheet (Attachment 5) instructs Qualified Shippers the specific capsules to be pulled from an Identified Host can, pull date and transfer to another Identified Host can.
- 7.0.7.1 In Attachment 5, capsules M2101 and SEP4 are to be pulled from host can #35 on 4/5/93 and transferred to host can #88.
- 7.0.7.2 Remaining capsules (Attachment 5) are shipped or stored.

Note:

*No new loading is indicated for the New Loading section (Attachment 5).*

- 7.0.8 The Existing Loading Sheet (Attachment 7) instructs Qualified Shippers the specific capsules to be pulled from an Identified host can, pull date, ship date, and their disposition.
- 7.0.8.1 The New Loading section (Attachment 7) indicates the transfer of Capsules (M2101 and SEP4) from another host can (#35) into host can (#88).
- 7.0.8.2 A new and different host can is assembled; this new host can number remains the same as before(#88).

NOTES:

*THE FOLLOWING STEPS FOR LOADING WILL BE ACCOMPLISHED USING THE ATTACHMENTS 1 THROUGH 7 OF THIS PROCEDURE AS AN AID AND THE HOST CAN NUMBERS WILL BE USED THROUGHOUT.*

*STEPS 7.1, 7.2, AND 7.3 ARE PERFORMED BY SERVICE APPLICATIONS-ISOTOPES GROUP.*

*APPROVED TRACKING AND HOST CAN INFORMATION SHEETS MENTIONED IN THE ABOVE STEPS ARE FOR INFORMATION ONLY TO INDICATE THE PAPER TRACK AND DO NOT PERTAIN TO SERVICE APPLICATIONS -SHIPPING.*

- 7.1 PREPARE PAPER WORK
- 7.1.1 Service Applications-Isotope Group, on receipt of MURR Irradiation Request Form assembles paperwork consisting of:
- Sample Pull Sheet, Attachment 2.
  - Sample Shipment Information Sheets, Attachments 4 and 6.
  - Existing Loading Sheets, Attachments 5 and 7.
- 7.1.2 The prepared paperwork is transferred to the Service Applications Section Leader- Shipping.
- 7.2 PREPARE NEW SAMPLES
- 7.2.1 Service Applications-Isotopes prepares new samples scheduled for irradiation by an Approved Tracking Sheet.
- 7.2.1.1 Sample preparation is initialed by Performer and Observer of the process.

7.3 PREPARE HOST CAPSULE AND HOST CAN

7.3.1 Service Applications-Isotope prepares new host cans and host capsules for irradiation by an approved Host Can Information Sheet.

7.3.1.1 Capsules are engraved with distinctive identification markings as indicated by Existing Loading Sheets.

7.3.1.2 Host cans are engraved with the host can number assigned by the Host Can Information Sheet and are indicated also on the Sample Shipment Information Sheet.

7.4 LOAD HOT CELL*NOTE:*

*THIS IS SIMILAR TO STEP 7.6 OF MURR-SAS-00002.*

7.4.1 Move the transfer cask to the immediate area of the hot cell.

7.4.2 Qualified Shipper dons protective clothing:

- Laboratory coat
- Rubber/latex gloves
- Breathing mask; type to minimize ingestion/inhalation of particulate matter for personnel who approach the hot cell door.
- Safety Glasses and /or face shield.

7.4.3 Move work table to North end of hot cell.

7.4.4 **Health Physics:**

7.4.4.1 Ensure air monitor is functional.

7.4.4.2 Turn hot cell blower "ON".

7.4.4.3 Open concrete shield outer door to hot cell and survey inner door of hot cell while outer door is opening.

- 7.4.5 Health Physics/Qualified Shipper:
- 7.4.5.1 Open aluminum inner wall door.
  - 7.4.5.2 Place clean absorbent paper on the South work table in hot cell.
  - 7.4.5.3 Load the new host cans and host capsules in the hot cell.
  - 7.4.5.4 Move the transfer cask to the front of the hot cell door by a fork lift.
  - 7.4.5.5 Remove safety pin and bar from the transfer cask.
  - 7.4.5.6 Remove the plastic bag from the transfer cask at the hot cell door.
  - 7.4.5.7 Insert transfer cask into hot cell with fork lift.
  - 7.4.5.8 Close inner hot cell aluminum door.
  - 7.4.5.9 Swipe floor outside of hot cell and read for contamination.
  - 7.4.5.10 Close outer concrete door.
  - 7.4.5.11 Turn hot cell blower "OFF".
  - 7.4.5.12 Lift lid from transfer cask using the crane.
  - 7.4.5.13 Remove transfer cask basket and place on upper work table.
  - 7.4.5.14 Manipulate host can #35 from the basket.
  - 7.4.5.15 Manipulate host can #88 from the basket.
  - 7.4.5.16 Replace basket into transfer cask or appropriate storage area for returning host cans to pool.
  - 7.4.5.17 Set transfer cask lid onto the transfer cask.
  - 7.4.5.18 Unhook lid from crane.

7.5 OPEN HOST CAN #1 (Example used: Can # 35)

## NOTE:

*THIS STEP 7.8 OF MURR-SAS-00002.*

- 7.5.1 Host can #35 is identified and verified by comparing the can inscription with Sample Shipment Information Sheet, (Attachment 4) Step 2, as can #35.
- 7.5.2 Performer and Observer initial Sample Shipment Information Sheet (Attachment 4), Step 2, verifying host can to be opened is correct(#35).
- 7.5.3 Cut top off of host can and place top into hot waste storage area of hot cell.
- 7.5.4 Remove capsule(s) from host can and place on clean absorbent paper.
- 7.5.5 Perform a visual inspection of the capsule after it is de-canned as shown in example on Sample Shipment information Sheet (Attachment 4) description (upper right corner):
- THIS IS A HOST CAN. PULL  
AND LOAD ACCORDING TO HOST  
CAPSULE CHANGE SHEET.
- 7.5.6 Identify and verify capsule(s) description by comparing the description on Sample Shipment Information Sheet (Attachment 4), and inscription on Existing Loading Sheet (Attachment 5).
- 7.5.7 Performer and Observer initial Step 4 of Sample Shipment Information Sheet (Attachment 4).
- 7.5.8 Place Identified capsules (#M2101 and SEP4) into a plastic cup and place in the holding area on the hot cell West work table.

- 7.6 OPEN HOST CAN #2 (Example used: Can #88)
- 7.6.1 Host can is identified and verified by comparing the can description with Sample Shipment Information Sheet, (Attachment 6) Step 2, as can #88.
- 7.6.2 Performer and Observer initial Sample Shipment Information Sheet (Attachment 6), Step 2, verifying host can to be opened is correct (#88).
- 7.6.3 Cut top off of host can and place top into hot waste storage area of hot cell.
- 7.6.4 Remove capsule(s) from host can and place on clean absorbent paper.
- 7.6.5 Perform a visual inspection of the capsule(s) after it is decanned as shown in example on Sample Shipment Information Sheet (Attachment 6) description (upper right corner):
- THIS IS A HOST CAN. PULL AND  
LOAD ACCORDING TO HOST  
CAPSULE CHANGE SHEET.
- 7.6.6 Identify and verify capsule(s) description by comparing the inscription(s) on Existing Loading Sheet (Attachment 7).
- 7.6.7 Performer and Observer initial Step 3 of Sample Shipment Information Sheet (Attachment 6).

7.7 LOAD NEW HOST CAN FOR FLUX TRAP

## NOTE:

FOR OTHER LOADING, CAPSULES, MAY COME FROM:

- STORAGE (STEP 7.11 OF MURR-SAS-00002)
- HOST CAN (STEP 7.11 OF MURR-SAS-00002)
- SERVICE APPLICATIONS-ISOTOPES (NEW)

- 7.7.1 Identify and put capsules 9550, MAR2, ABA, and 816 from the Original host can #88 into the New host can #88.
- 7.7.2 Identify and install capsules M2101 and SEP4 transferred from host can #35 also into the new host can #88.
- 7.7.3 Performer and Observer initial Existing Loading Sheet in the New Loading Section (Attachment 7).
- 7.7.4 Place lid onto the new host can #88.
- 7.7.5 Place the new host can (# 88) into hot cell storage area.

## NOTE:

MACHINE SHOP PERSONNEL DO NOT USE THE MANIPULATORS EXCEPT TO INSERT/REMOVE HOST CANS TO WELDING RIG.

7.8 WELD NEW HOST CAN

- 7.8.1 Machine Shop personnel weld the lid onto the host can using:
- Welding unit, Miller 330A/BP or equivalent.
  - Tec Torch Model 308 or equivalent.

7.9 SIZE NEW HOST CAN

- 7.9.1 Manipulate the host can through the sizing tube to verify host can is of correct size to be accepted into the flux trap.

## NOTE:

The host can must be able to pass through the sizing tube freely.

- 7.9.1.1 If the host can is too large to pass through the sizing tube, use the manipulators and a file to size the host can. Repeat Step 7.9.1.

7.10 LEAK TEST HOST CAN

- 7.10.1 Remove the lid from the Leak Test jar.
- 7.10.2 Insert host can into Leak Test jar.
- 7.10.3 Install the lid onto the Leak Test jar.

*NOTES:*

*The Vent and Vacuum valve handles for the following test are located on a panel in the upper right hand corner of the West hot cell window.*

*The vent and vacuum valves handles are moved to the "IN" position to "CLOSE" the valves and moved to the "OUT" position to "OPEN" the valves.*

*Watch for bubbles at all times when placed in alcohol.*

- 7.10.4 Verify that the Vent and Vacuum valves are both "CLOSED"
- 7.10.5 "OPEN" the Vacuum valve and observe if any bubbles are coming from the host can.

*NOTE:*

*This next Step assures that vacuum is operational.*

- 7.10.6 Raise the Leak Test jar approximately one inch off the work table by the lid of the jar.
- 7.10.7 Carefully lower the Leak Test jar to the work table.
- 7.10.8 Observe for bubbles leaking from the host can for approximately 30 seconds.
  - 7.10.8.1 Bubbles indicates a leaky host can: Proceed to Step 7.14.
  - 7.10.8.2 No bubbles indicates the host can has integrity.
- 7.10.9 Close the vacuum valve.
- 7.10.10 Open the vent valve.
- 7.10.11 Close the vent valve when the vacuum has been vented.

- 7.10.12 Remove the lid from the Leak Test jar.
- 7.10.13 Remove the Host can from the Leak Test jar.
- 7.10.14 Load host can into transfer cask basket.
- 7.10.15 Load basket into transfer cask after all host cans have been leaked checked.
- 7.10.16 Replace transfer cask lid onto the transfer cask.
- 7.11 UNLOAD HOT CELL

NOTES:

*PERFORM A VISUAL INSPECTION OF THE HOT CELL TO ENSURE THAT ALL WORKING AREAS ARE SECURED AND THAT DOORS CAN BE OPENED.*

*MOVE TRANSFER TABLE TO NORTH END OF HOT CELL AND ADJUST TO CORRECT LEVEL FOR FORK LIFT ENTRY.*

*THIS IS SIMILAR TO STEP 7.13 OF MURR-SAS-00002.*

- 7.11.1 Health Physics/Qualified Shipper:
  - 7.11.1.1 Turn hot cell blower "ON."
  - 7.11.1.2 Open concrete outer door to hot cell and survey inner door of hot cell while door is opening.
  - 7.11.1.3 Open aluminum inner wall door.
  - 7.11.1.4 Swipe and read transfer cask.
  - 7.11.1.5 Inspect poly bag to be used to bag the transfer cask for holes or tears.
  - 7.11.1.6 Remove transfer cask from hot cell using fork lift.
  - 7.11.1.7 Bag the transfer cask.
  - 7.11.1.8 Place transfer cask on a cart.
  - 7.11.1.9 Replace safety bar and pin.
  - 7.11.1.10 Survey transfer cask on cart.

- 7.11.1.11 Close the inner hot cell door.
- 7.11.1.12 Close outer hot cell door.
- 7.11.1.13 Turn hot cell blower "OFF"
- 7.11.1.14 Swipe and read floor outside of the hot cell door using Baird Polyspec Research Spectrometer or equivalent to count the swipes.
- 7.12 TRANSFER TO POOL FOR RELOAD

*CAUTION:*

*Personnel transporting transfer cask to the pool must practice ALARA, (TIME, DISTANCE, SHIELDING).*

***DO NOT RIDE ELEVATOR WITH CASK.***

- 7.12.1 Transport cask is transported to the pool by way of Containment and Freight elevators or door 101 when available.

7.13 COMPLETE PAPER WORK

- 7.13.1 The following paper work is transferred between Service Applications-Shipping and Service Applications-Isotopes:
- Sample Pull Sheet, Attachment 2.
  - Sample Sheet, Attachment 3.
  - Sample Shipment Information Sheets, Attachments 4 and 6.
  - Existing Loading Sheets, Attachments 5 and 7. (Mondays only) for host can loading.
- 7.13.2 Originally, the above paper work is generated by Service Applications-Isotopes and transferred to Service Applications-Shipping.
- 7.13.3 Prior to when the Shippers go to the hot cell the Sample Sheet is returned to Isotopes.
- 7.13.3.1 Isotopes enters the information of the Sample Sheet into the Data Base.
- 7.13.3.2 The Sample Sheet is returned to Shipping.
- 7.13.4 After the package is shipped the Documentation Packet, which includes, the Sample Sheet and Sample Shipment Information Sheet is returned to Isotopes where it remains until Billing.
- 7.13.4.1 The Sample Pull Sheet is filed by the Shipping Department.
- 7.13.4.2 On routine reactor shutdown days (host can loading) the Existing Loading Sheet is returned by placing it into the "In-basket" of Isotopes.
- 7.13.5 After the Billing, the paper work is transferred to Service Applications Section Leader- Shipping.
- 7.13.6 The Service Applications Section Leader- Shipping:
- Files the paper work in numerical order and maintains this paper work at MURR for a period of three years.
  - Performs sampling of the documents for accuracy.
- 7.13.7 After a three year period, this paper work is sent to the University of Missouri Records Retirement Storage.

7.14 OPEN LEAKY HOST CAN AND DRY*NOTE:*

*IF HOST CAN LEAKS, CUT HOST CAN OPEN, REMOVE CAPSULES AND ALLOW CAPSULES TO DRY FOR 30 MINUTES.*

- 7.14.1 Host can is identified and verified by comparing the can inscription with Sample Shipment Information Sheet, (Attachment 6) Step 2, as can # 88.
- 7.14.2 Performer indicates that the host can leaked, by making a note on Existing Loading Sheet (Attachment 7).
- 7.14.3 Cut top off of host can and place top into hot waste storage area of hot cell.
- 7.14.4 Remove capsule(s) from leaky host can and place on clean absorbent paper.
- 7.14.5 Allow removed capsules to dry for 30 minutes prior to loading into a new host can.
- 7.14.6 Place capsules into temporary storage.
- 7.14.7 If new host can leaks: Repeat Procedure Steps 7.7, 7.8, 7.9 and 7.10.

ATTACHMENTS

- A. Hot Cell Loading of Host Cans, Attachment 1.
- B. Sample Pull Sheet, Attachment 2.
- C. Sample Sheet, Attachment 3.
- B. Sample Shipment Information Sheets, Attachments 4 and 6.
- C. Existing Loading Sheets, Attachments 5 and 7.

REFERENCE

- A. Federal Code of Regulations 10CFR.
- B. Federal Code of Regulations 49CFR.
- C. International Air Transport Association, Dangerous Goods Regulations.
- D. MURR, Reactor Technical Specifications.
- E. Hot Cell Preparation of Radioactive Material for Shipment, MURR-SAS-00002.
- F. Shipment of Radioactive Materials, MURR-SAS-00004.

### SECTION III

#### REVISIONS TO THE HAZARDS SUMMARY REPORT

1 July 1993 through 31 December 1993

#### HAZARDS SUMMARY REPORT (Original July 1, 1965)

Original Hazard Summary Report, Section 7.2.2, page 7-16, line 7:

Delete: *"as well as the supply of demineralized water to various laboratories."*

Original Hazard Summary Report, Section 7.2.2, page 7-16, Paragraph 3 is changed to read:

*"The two tanks are isolated from the facility demineralized water system. The two tanks can be cross-connected by a gate valve between the tanks."*

Original Hazard Summary Report, Section 7.2.2, page 7-17, new paragraph:

*"Three 420 gallon, 304 stainless steel demineralized water tanks are located in the north tower of the reactor building. The tanks are used for supplying demineralized water to the facility. The tanks are connected with PVC pipe to the laboratory demineralized water distribution system. The tanks have high and low level alarms which annunciate in the control room. They also have a "tank full" cutout switch associated with them so that when the tank is full the reverse osmosis (RO) unit used to fill them is shutdown automatically."*

## SECTION IV

### PLANT AND SYSTEM MODIFICATIONS

1 July 1993 through 31 December 1993

**Modification 93-1:** The installation of three new demineralized water tanks in north tower

This modification adds three (3) 420 gallon, 304 stainless steel tanks with a repressurization system to the facility demineralized water system for non-reactor system use. The original 7,000 gallon DI tank (T-300) has been physically separated from the facility demineralized water system and will supply pool and primary system make-up water needs.

The safety evaluation for this modification documents that it does not present an unreviewed safety question as per 10CFR50.59.

## SECTION V

### NEW TESTS AND EXPERIMENTS 1 July 1993 through 31 December 1993

New experimental programs during this period are as follows:

#### **RUR-305, Ruthenium Metal:**

Experimenter: S. Gunn  
Description: This RUR authorized irradiation of ruthenium metal for medical use.

#### **RUR-315, Rubidium Carbonate:**

Experimenter: S. Gunn  
Description: This RUR authorized irradiation of rubidium carbonate for medical research use.

Each of these experiments has a written safety evaluation on file which provides the basis for the determination that it does not involve an unreviewed safety question as per 10 CFR 50.59.

SECTION VI

SPECIAL NUCLEAR MATERIAL ACTIVITIES

1 July 1993 through 31 December 1993

1. SNM Receipts: A total of 16 new fuel elements were received from Babcock and Wilcox (B & W), Lynchburg, Virginia.

| Shipper | Elements   | Grams  | Grams  |
|---------|--|--------|--------|
|         |  | U      | U-235  |
| B & W   | MO-385, MO-386, MO-387, MO-388, MO-389, MO-390, MO-391, MO-392, MO-393, MO-394, MO-395, MO-396, MO-397, MO-398, MO-399, MO-400 | 13,294 | 12,374 |

2. SNM Shipments: A total of 24 spent fuel elements were shipped to DOE facilities at Savannah River Plant, Aiken, South Carolina.

| Shipper | Elements   | Grams  | Grams  |
|---------|--|--------|--------|
|         |  | U      | U-235  |
| MURR    | MO-316, MO-318, MO-319, MO-320, MO-323, MO-324, MO-325, MO-326, MO-327, MO-328, MO-329, MO-330, MO-331, MO-332, MO-333, MO-334, MO-335, MO-336, MO-337, MO-338, MO-339, MO-340, MO-341, MO-342 | 16,177 | 14,115 |

3. Inspections: Physical Security and Material Control and Accountability inspections were conducted by the Nuclear Regulatory Commission during the time period July 14-16, 1993. No violations of NRC requirements were identified during the course of these inspections.
4. SNM Inventory: As of 31 December 1993, MURR was financially responsible for the following DOE-owned amounts:

Total U = 44,192 grams

Total U-235 = 39,688 grams

Included in these totals are 36 grams of U and 34 grams of U-235 in DOE-owned non-fuel. In addition to these totals, MURR owns 177 grams of U and 96 grams of U-235. All of this material is physically located at the MURR.

The fuel elements on hand have accumulated the following burn-ups as of 31 December 1993:

Burned-up Elements (16)

| <u>Element No.</u> | <u>MWD</u> | <u>Element No.</u> | <u>MWD</u> | <u>Element No.</u> | <u>MWD</u> |
|--------------------|------------|--------------------|------------|--------------------|------------|
| MO-321             | 126.29     | MO-347             | 137.81     | MO-353             | 147.50     |
| MO-322             | 126.29     | MO-348             | 145.31     | MO-354             | 136.11     |
| MO-343             | 146.30     | MO-349             | 137.81     | MO-359             | 135.08     |
| MO-344             | 146.07     | MO-350             | 145.31     | MO-360             | 135.08     |
| MO-345             | 146.30     | MO-351             | 147.50     |                    |            |
| MO-346             | 146.07     | MO-352             | 136.11     |                    |            |

Elements in Service (44)

|        |        |        |        |        |       |
|--------|--------|--------|--------|--------|-------|
| MO-355 | 108.48 | MO-372 | 104.63 | MO-387 | 42.12 |
| MO-356 | 108.48 | MO-373 | 100.82 | MO-388 | 50.17 |
| MO-357 | 92.92  | MO-374 | 104.65 | MO-389 | 46.37 |
| MO-358 | 92.92  | MO-375 | 100.82 | MO-390 | 42.73 |
| MO-361 | 116.99 | MO-376 | 104.65 | MO-391 | 46.37 |
| MO-362 | 103.37 | MO-377 | 81.03  | MO-392 | 42.73 |
| MO-363 | 116.99 | MO-378 | 77.21  | MO-393 | 33.11 |
| MO-364 | 103.37 | MO-379 | 81.03  | MO-394 | 0.00  |
| MO-365 | 103.78 | MO-380 | 77.21  | MO-395 | 33.11 |
| MO-366 | 122.96 | MO-381 | 68.15  | MO-396 | 0.00  |
| MO-367 | 103.78 | MO-382 | 71.28  | MO-397 | 0.00  |
| MO-368 | 122.96 | MO-383 | 68.15  | MO-398 | 0.00  |
| MO-369 | 88.22  | MO-384 | 71.28  | MO-399 | 0.00  |
| MO-370 | 104.63 | MO-385 | 42.12  | MO-400 | 0.00  |
| MO-371 | 88.22  | MO-386 | 50.17  |        |       |

Average Burn-up (all elements): 89.32 MWD

## SECTION VII

### REACTOR PHYSICS ACTIVITIES 1 July 1993 through 31 December 1993

1. Fuel Utilization: During the period 1 July 1993 through 31 December 1993, the following elements reached licensed or feasible burn-up and were retired:

| <u>Serial Number</u> | <u>Final Core</u> | <u>Date Last Used</u> | <u>MWD</u> |
|----------------------|-------------------|-----------------------|------------|
| MO-321               | 93-56             | 11-01-93              | 126.29     |
| MO-322               | 93-56             | 11-01-93              | 126.29     |
| MO-347               | 93-40             | 07-26-93              | 137.81     |
| MO-349               | 93-40             | 07-26-93              | 137.81     |
| MO-352               | 93-49             | 09-27-93              | 136.11     |
| MO-354               | 93-49             | 09-27-93              | 136.11     |
| MO-359               | 93-64             | 12-20-93              | 135.08     |
| MO-360               | 93-64             | 12-20-93              | 135.08     |

Due to the requirement of having less than 5 kg of unirradiated fuel in possession, initial criticalities are obtained with four new elements or fewer as conditions dictate. A core designation consists of eight fuel elements of which only the initial critical fuel element serial numbers are listed in the following table of elements in service 31 December 1993. To increase operating efficiency, fuel elements are used in mixed core loadings. Therefore, a fuel element fabrication core number is different from its core load number.

| <u>Serial Number</u> | <u>Fabrication Core Number</u> | <u>Initial Core Load Number</u> | <u>Initial Operating Date</u> |
|----------------------|--------------------------------|---------------------------------|-------------------------------|
| MO-381               | 63                             | 93-40                           | 07-19-93                      |
| MO-382               | 63                             | 93-41                           | 07-26-93                      |
| MO-383               | 64                             | 93-40                           | 07-19-93                      |
| MO-384               | 64                             | 93-41                           | 07-26-93                      |
| MO-385               | 64                             | 93-48                           | 09-13-93                      |
| MO-386               | 64                             | 93-49                           | 09-20-93                      |
| MO-387               | 64                             | 93-48                           | 09-13-93                      |
| MO-388               | 64                             | 93-49                           | 09-20-93                      |
| MO-389               | 64                             | 93-51                           | 10-04-93                      |
| MO-390               | 64                             | 93-56                           | 10-25-93                      |
| MO-391               | 65                             | 93-51                           | 10-04-93                      |
| MO-392               | 65                             | 93-56                           | 10-25-93                      |
| MO-393               | 65                             | 93-62                           | 11-29-93                      |
| MO-395               | 65                             | 93-62                           | 11-29-93                      |

2. Fuel Shipments: Twenty-four spent fuel elements were shipped from MURR to Savannah River Plant, Aiken, South Carolina. The identification numbers of these elements are:

|        |        |        |        |
|--------|--------|--------|--------|
| MO-316 | MO-325 | MO-331 | MO-337 |
| MO-318 | MO-326 | MO-332 | MO-338 |
| MO-319 | MO-327 | MO-333 | MO-339 |
| MO-320 | MO-328 | MO-334 | MO-340 |
| MO-323 | MO-329 | MO-335 | MO-341 |
| MO-324 | MO-330 | MO-336 | MO-342 |

3. Fuel Procurement: Babcock and Wilcox, Lynchburg, Virginia, is MURR's fuel assembly fabricator. This work is contracted with the U. S. Department of Energy and administered by EG&G Idaho Inc., Idaho Falls, Idaho. As of 31 December 1993, 201 fuel assemblies fabricated by B & W had been received and 195 used in cores at 10 MW.
4. Licensing Activities: On July 21, 1993, the Nuclear Regulatory Commission approved Amendment No. 24 to the facility operating license R-103. This amendment temporarily increased the Special Nuclear Material inventory limit to 60 kg U-235 pending the completion of spent fuel shipments.

This amendment requires that this annual report include the status of these shipments. Twenty-four spent fuel elements were shipped in the period of this report, and one shipment of eight elements is scheduled in 1994. After the 1994 shipment, the MURR fuel and non-fuel U-235 inventory will be 37,600 grams.

A request for a unique purpose exemption as defined in 10CFR50.2 was submitted September 26, 1986, and is pending.

5. Reactor Characteristic Measurements: Thirty refueling evolutions were completed. An excess reactivity verification was performed for each refueling and the average excess reactivity was 1.97%. The largest excess reactivity was 2.59%. MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

Reactivity measurements were performed for two evolutions to verify reactivity parameters for the flux trap. Differential and total worth measurements were made on blade C.

## SECTION VIII

### SUMMARY OF RADIOACTIVE EFFLUENT RELEASED TO THE ENVIRONMENT

The stack and sewer effluent for the first half of 1993 was reported in our fiscal year 92/93 Annual Report. The data for the second half of 1993 is reported in Table 1 and Table 2. Table 3 and Table 4 show the effluents for the entire calendar year of 1993. The information in the 92/93 Annual Report and these tables demonstrate compliance with effluent release limits for both Fiscal Year 92/93 and Calendar Year 1993.

Table 1. Sanitary Sewer Effluent  
1 July 1993 through 31 December 1993

Descending Order of Activity Released for Isotope Totals > 1.00 E-5 Ci:

| <u>Nuclide</u> | <u>Amount (Ci)</u> | <u>Nuclide</u> | <u>Amount (Ci)</u> |
|----------------|--------------------|----------------|--------------------|
| H-3            | 8.627E-02          | Sc-46          | 4.987E-05          |
| S-35           | 6.915E-03          | Pd-109         | 4.911E-05          |
| As-77          | 3.322E-03          | Na-24          | 4.674E-05          |
| Ca-45          | 2.825E-03          | Sb-125         | 2.558E-05          |
| Co-58          | 6.089E-04          | Re-186         | 2.227E-05          |
| Cr-51          | 4.753E-04          | Co-60          | 2.175E-05          |
| Te-125m        | 3.340E-04          | Eu-152         | 1.880E-05          |
| Eu-154         | 1.149E-04          | Se-75          | 1.848E-05          |
| Zn-65          | 5.287E-05          | Co-57          | 1.613E-05          |

Table 2. Stack Effluent  
1 July 1993 through 31 December 1993

Ordered by % Technical Specification (TS) Limit

| Isotope | Average<br>Concentration<br>(uCi/ml) | Total Release<br>6/93 - 12/93<br>(Ci) | TS Limit<br>x MPC | % TS*  |
|---------|--------------------------------------|---------------------------------------|-------------------|--------|
| Ar-41   | 5.56E-07                             | 1.4E+02                               | 350               | 3.9714 |
| W-188   | 2.78E-12                             | 2.6E-05                               | 1                 | 2.7840 |
| I-131   | 7.88E-13                             | 2.0E-04                               | 1                 | 0.7875 |
| Pd-103  | 2.21E-10                             | 1.9E-03                               | 1                 | 0.7352 |
| K-40    | 7.17E-13                             | 1.9E-05                               | 1                 | 0.7169 |
| Cd-109  | 2.11E-12                             | 9.9E-05                               | 1                 | 0.1053 |
| Ba-133  | 9.47E-14                             | 1.9E-06                               | 1                 | 0.0947 |
| Eu-152  | 3.02E-13                             | 3.3E-06                               | 1                 | 0.0755 |
| H-3     | 3.76E-08                             | 9.4E+00                               | 350               | 0.0537 |
| Hf-181  | 4.22E-13                             | 2.0E-06                               | 1                 | 0.0422 |
| Ce-144  | 7.88E-14                             | 3.6E-06                               | 1                 | 0.0394 |
| Tm-170  | 2.86E-13                             | 2.3E-06                               | 1                 | 0.0286 |
| Ce-139  | 2.80E-14                             | 8.4E-07                               | 1                 | 0.0280 |
| Co-60   | 5.68E-14                             | 4.9E-06                               | 1                 | 0.0189 |
| Cd-115  | 1.86E-13                             | 1.3E-06                               | 1                 | 0.0186 |
| Te-123m | 1.79E-14                             | 3.9E-07                               | 1                 | 0.0179 |
| Cs-137  | 4.78E-14                             | 1.6E-06                               | 1                 | 0.0096 |
| Na-22   | 2.22E-14                             | 2.5E-07                               | 1                 | 0.0074 |
| Ir-192  | 5.13E-14                             | 8.3E-07                               | 1                 | 0.0057 |
| Zr-95   | 5.54E-14                             | 4.5E-07                               | 1                 | 0.0055 |
| Sc-46   | 4.42E-14                             | 3.6E-07                               | 1                 | 0.0055 |
| Se-75   | 2.09E-13                             | 4.5E-05                               | 1                 | 0.0052 |
| I-135   | 1.55E-11                             | 3.5E-03                               | 350               | 0.0044 |
| I-133   | 6.18E-12                             | 1.7E-03                               | 350               | 0.0044 |
| Pt-195m | 1.17E-12                             | 7.5E-06                               | 350               | 0.0033 |
| Re-188  | 6.56E-11                             | 1.6E-04                               | 350               | 0.0031 |
| Mn-54   | 3.03E-14                             | 4.8E-07                               | 1                 | 0.0030 |
| I-134   | 4.49E-11                             | 1.1E-02                               | 350               | 0.0021 |
| Xe-135m | 2.23E-10                             | 6.4E-03                               | 350               | 0.0021 |
| I-128   | 1.91E-10                             | 1.2E-02                               | 350               | 0.0018 |
| Hg-203  | 6.19E-14                             | 1.6E-05                               | 1                 | 0.0015 |
| Au-196  | 1.07E-10                             | 1.0E-03                               | 350               | 0.0015 |
| Ta-182  | 1.48E-14                             | 1.4E-07                               | 1                 | 0.0015 |

\*Isotopes observed at < 0.0001% TS limit are not listed.

Table 2. Stack Effluent (Cont'd)  
1 July 1993 through 31 December 1993

| Isotope      | Average<br>Concentration<br>(uCi/ml) | Total Release<br>6/93 - 12/93<br>(Ci) | TS Limit<br>x MPC | % TS*         |
|--------------|--------------------------------------|---------------------------------------|-------------------|---------------|
| Pa-233       | 7.81E-14                             | 1.4E-06                               | 1                 | 0.0013        |
| I-132        | 1.35E-11                             | 3.2E-03                               | 350               | 0.0013        |
| Eu-155       | 3.25E-14                             | 1.4E-06                               | 1                 | 0.0011        |
| Ba-133m      | 3.19E-13                             | 5.4E-06                               | 350               | 0.0009        |
| Sb-125       | 1.76E-13                             | 1.0E-06                               | 1                 | 0.0009        |
| As-77        | 2.54E-11                             | 3.4E-03                               | 350               | 0.0007        |
| Ce-141       | 3.23E-14                             | 1.8E-06                               | 1                 | 0.0006        |
| Os-191       | 5.02E-14                             | 2.2E-06                               | 1                 | 0.0005        |
| Sn-113       | 9.00E-15                             | 9.5E-08                               | 1                 | 0.0004        |
| Gd-153       | 3.31E-14                             | 2.7E-07                               | 1                 | 0.0004        |
| Tc-101       | 3.13E-11                             | 1.3E-03                               | 350               | 0.0003        |
| Cu-67        | 1.03E-13                             | 3.8E-06                               | 350               | 0.0003        |
| Pd-109       | 8.93E-12                             | 4.7E-04                               | 350               | 0.0003        |
| Ta-183       | 8.02E-14                             | 7.8E-07                               | 350               | 0.0002        |
| Cs-138       | 2.35E-11                             | 6.2E-04                               | 350               | 0.0002        |
| Xe-131m      | 6.00E-13                             | 1.1E-05                               | 1                 | 0.0001        |
| Ba-139       | 1.25E-11                             | 6.0E-04                               | 350               | 0.0001        |
| In-114m      | 2.70E-13                             | 5.2E-06                               | 350               | 0.0001        |
| Kr-87        | 4.27E-12                             | 1.4E-04                               | 350               | 0.0001        |
| <b>Total</b> |                                      |                                       |                   | <b>9.5952</b> |

\*Isotopes observed at < 0.0001% TS limit are not listed.

Stack flow rate 33,500 cfm

Table 3. Sanitary Sewer Effluent  
1 January 1993 through 31 December 1993

Descending Order of Activity Released for Isotope Totals > 1.00 E-5 Ci:

| <u>Nuclide</u> | <u>Amount (Ci)</u> | <u>Nuclide</u> | <u>Amount (Ci)</u> |
|----------------|--------------------|----------------|--------------------|
| H-3            | 2.574E-01          | Na-24          | 3.013E-04          |
| Eu-154         | 3.012E-02          | Se-75          | 2.151E-04          |
| S-35           | 1.184E-02          | W-188          | 1.501E-04          |
| As-77          | 8.293E-03          | Sc-46          | 1.169E-04          |
| Ca-45          | 3.335E-03          | Pd-109         | 7.775E-05          |
| Te-125m        | 1.156E-03          | Ba-131         | 7.571E-05          |
| Re-186         | 9.153E-04          | Eu-152         | 6.974E-05          |
| Co-58          | 6.595E-04          | Cd-109         | 5.192E-05          |
| Cr-51          | 5.182E-04          | Sb-125         | 4.084E-05          |
| Co-60          | 4.142E-04          | Co-57          | 3.305E-05          |
| Zn-65          | 3.083E-04          | Ce-144         | 2.433E-05          |
|                |                    | Total H-3      | 2.574E-01          |
|                |                    | Total Other    | 5.871E-02          |

Table 4. Stack Effluent  
1 January 1993 through December 1993

Ordered by % Technical Specification (TS) Limit

| Isotope | Average<br>Concentration<br>(uCi/ml) | Total Release<br>1993<br>(Ci) | MPC<br>(uCi/ml) | TS Limit<br>x MPC | % TS*  |
|---------|--------------------------------------|-------------------------------|-----------------|-------------------|--------|
| Ar-41   | 8.20E-07                             | 4.09E+02                      | 4E-08           | 350               | 5.8571 |
| W-188   | 2.78E-12                             | 2.57E-05                      | 1E-10           | 1                 | 2.7840 |
| I-131   | 7.73E-13                             | 3.80E-04                      | 1E-10           | 1                 | 0.7727 |
| K-40    | 5.89E-13                             | 2.14E-05                      | 1E-10           | 1                 | 0.5885 |
| Pd-103  | 1.35E-10                             | 2.92E-03                      | 3E-08           | 1                 | 0.4512 |
| Eu-152  | 3.02E-13                             | 3.34E-06                      | 4E-10           | 1                 | 0.0755 |
| Cd-109  | 1.26E-12                             | 1.26E-04                      | 2E-09           | 1                 | 0.0632 |
| H-3     | 3.12E-08                             | 1.56E+01                      | 2E-07           | 350               | 0.0446 |
| Hf-181  | 4.22E-13                             | 2.00E-06                      | 1E-09           | 1                 | 0.0422 |
| Pt-195m | 1.17E-12                             | 7.48E-06                      | 3E-09           | 1                 | 0.0389 |
| Ce-144  | 7.49E-14                             | 4.22E-06                      | 2E-10           | 1                 | 0.0374 |
| Tm-170  | 2.86E-13                             | 2.27E-06                      | 1E-09           | 1                 | 0.0286 |
| Ce-139  | 2.16E-14                             | 1.49E-06                      | 1E-10           | 1                 | 0.0216 |
| Te-123m | 1.79E-14                             | 3.86E-07                      | 1E-10           | 1                 | 0.0179 |
| Co-60   | 5.26E-14                             | 6.72E-06                      | 3E-10           | 1                 | 0.0175 |
| Ba-140  | 1.46E-13                             | 3.34E-06                      | 1E-09           | 1                 | 0.0146 |
| Cd-115  | 1.34E-13                             | 2.11E-06                      | 1E-09           | 1                 | 0.0134 |
| Cs-137  | 4.12E-14                             | 2.33E-06                      | 5E-10           | 1                 | 0.0082 |
| Na-22   | 2.22E-14                             | 2.45E-07                      | 3E-10           | 1                 | 0.0074 |
| Cs-134  | 6.10E-14                             | 7.47E-07                      | 1E-09           | 1                 | 0.0061 |
| Ir-192  | 5.13E-14                             | 8.35E-07                      | 9E-10           | 1                 | 0.0057 |
| Sc-46   | 4.42E-14                             | 3.59E-07                      | 8E-10           | 1                 | 0.0055 |
| Se-75   | 2.01E-13                             | 7.59E-05                      | 4E-09           | 1                 | 0.0050 |
| Zr-95   | 4.47E-14                             | 8.13E-07                      | 1E-09           | 1                 | 0.0045 |
| I-133   | 6.24E-12                             | 3.23E-03                      | 4E-10           | 350               | 0.0045 |
| I-135   | 1.55E-11                             | 7.11E-03                      | 1E-09           | 350               | 0.0044 |
| Ba-133  | 9.47E-14                             | 1.86E-06                      | 3E-09           | 1                 | 0.0032 |
| Mn-54   | 3.03E-14                             | 4.84E-07                      | 1E-09           | 1                 | 0.0030 |
| Xe-135m | 3.15E-10                             | 1.70E-02                      | 3E-08           | 350               | 0.0030 |
| I-131*  | 4.67E-11                             | 2.23E-02                      | 6E-09           | 350               | 0.0022 |
| Hg-203  | 7.50E-14                             | 3.66E-05                      | 4E-09           | 1                 | 0.0019 |
| Re-188  | 3.30E-11                             | 1.64E-04                      | 6E-09           | 350               | 0.0016 |
| Au-196  | 1.07E-10                             | 1.02E-03                      | 2E-08           | 350               | 0.0015 |
| Ta-182  | 1.48E-14                             | 1.41E-07                      | 1E-09           | 1                 | 0.0015 |

\*Isotopes observed at < 0.0001% TS limit are not listed.

Table 4. Stack Effluent (Cont'd)  
1 January 1993 through 31 December 1993

| Isotope      | Average<br>Concentration<br>(uCi/ml) | Total Release<br>6/93 - 12/93<br>(Ci) | MPC<br>(uCi/ml) | TS Limit<br>x MPC | % TS*          |
|--------------|--------------------------------------|---------------------------------------|-----------------|-------------------|----------------|
| Zn-65        | 2.90E-14                             | 6.38E-07                              | 2E-09           | 1                 | 0.0015         |
| I-128        | 1.40E-10                             | 1.49E-02                              | 3E-08           | 350               | 0.0013         |
| I-132        | 1.37E-11                             | 6.46E-03                              | 3E-09           | 350               | 0.0013         |
| Eu-155       | 3.25E-14                             | 1.35E-06                              | 3E-09           | 1                 | 0.0011         |
| Pa-233       | 6.26E-14                             | 1.91E-06                              | 6E-09           | 1                 | 0.0010         |
| Sb-125       | 1.76E-13                             | 1.02E-06                              | 2E-08           | 1                 | 0.0009         |
| Nb-95        | 2.39E-14                             | 5.34E-07                              | 3E-09           | 1                 | 0.0008         |
| Ba-133m      | 2.68E-13                             | 6.50E-06                              | 1E-10           | 350               | 0.0008         |
| Ce-141       | 3.23E-14                             | 1.77E-06                              | 5E-09           | 1                 | 0.0006         |
| Sn-113       | 1.29E-14                             | 5.00E-07                              | 2E-09           | 1                 | 0.0006         |
| Sr-85        | 2.00E-14                             | 1.56E-07                              | 4E-09           | 1                 | 0.0005         |
| As-77        | 1.73E-11                             | 4.79E-03                              | 1E-08           | 350               | 0.0005         |
| Ru-103       | 1.31E-14                             | 2.60E-07                              | 3E-09           | 1                 | 0.0004         |
| Os-191       | 3.61E-14                             | 4.08E-06                              | 1E-08           | 1                 | 0.0004         |
| Tc-101       | 3.13E-11                             | 1.26E-03                              | 3E-08           | 350               | 0.0003         |
| Gd-153       | 2.26E-14                             | 6.19E-07                              | 8E-09           | 1                 | 0.0003         |
| Ta-183       | 8.02E-14                             | 7.80E-07                              | 1E-10           | 350               | 0.0002         |
| Cr-51        | 1.83E-13                             | 4.16E-06                              | 8E-08           | 1                 | 0.0002         |
| Cu-67        | 7.95E-14                             | 8.95E-06                              | 1E-10           | 350               | 0.0002         |
| Pd-109       | 6.62E-12                             | 5.53E-04                              | 1E-08           | 350               | 0.0002         |
| Cs-138       | 1.76E-11                             | 6.24E-04                              | 3E-08           | 350               | 0.0002         |
| Kr-87        | 1.08E-11                             | 6.63E-04                              | 2E-08           | 350               | 0.0002         |
| Xe-131m      | 6.00E-13                             | 1.12E-05                              | 4E-07           | 1                 | 0.0001         |
| Co-57        | 5.66E-15                             | 5.55E-08                              | 6E-09           | 1                 | 0.0001         |
| In-114m      | 2.18E-13                             | 5.85E-06                              | 7E-10           | 350               | 0.0001         |
| Ba-139       | 9.31E-12                             | 1.04E-03                              | 3E-08           | 350               | 0.0001         |
| <b>Total</b> |                                      |                                       |                 |                   | <b>10.9520</b> |

\*Isotopes observed at < 0.0001% TS limit are not listed.

Stack flow rate 33,500 cfm

## SECTION IX

### SUMMARY OF ENVIRONMENTAL SURVEYS 1 July 1993 through 31 December 1993

Environmental samples are collected two times per year at eight locations (HP-11: "Environmental Sampling") and analyzed for radioactivity. These locations are shown in Figure 1. Soil and vegetation samples are taken at each location. Water samples are taken at three of the eight locations. Results of the samples are shown in the following tables.

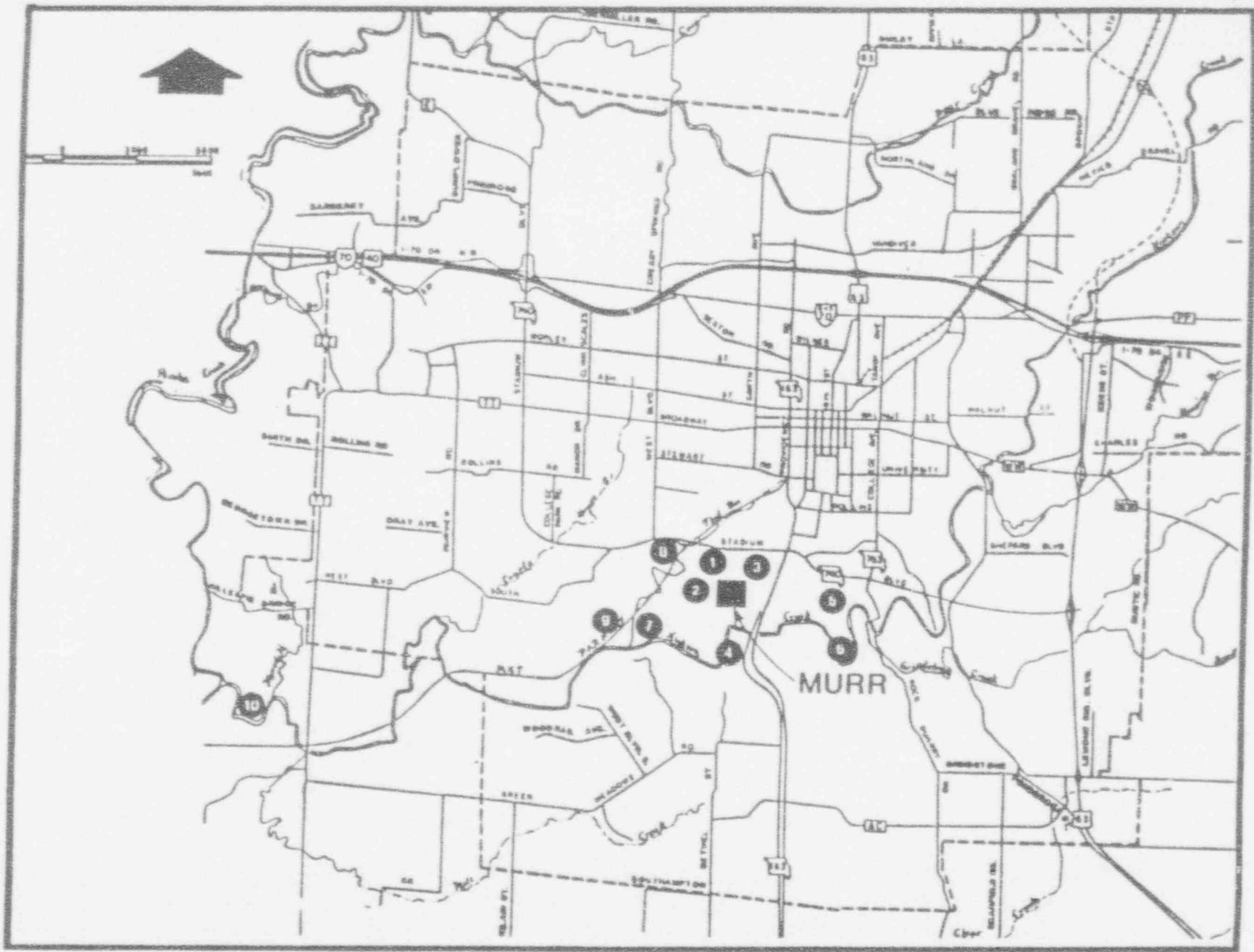
#### 1. Sampled during December 1993.

| <u>Matrix</u> | <u>Detection Limits*</u> |             |              |                              |
|---------------|--------------------------|-------------|--------------|------------------------------|
|               | <u>Alpha</u>             | <u>Beta</u> | <u>Gamma</u> | <u>Tritium</u>               |
| Water         | 0.5 pCi/l                | 2.7 pCi/l   | 200.5 pCi/l  | 13.6 pCi/ml<br>of sample     |
| Soil          | 0.5 pCi/g                | 2.7 pCi/g   | 0.4 pCi/g    | N/A                          |
| Vegetation    | 1.0 pCi/g                | 5.4 pCi/g   | 1.4 pCi/g    | 13.6 pCi/ml<br>of distillate |

\* Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

#### Determined Radioactivity Levels Vegetation Samples

| <u>Sample</u> | <u>Alpha</u><br><u>(pCi/g)</u> | <u>Beta</u><br><u>(pCi/g)</u> | <u>Gamma</u><br><u>(pCi/g)</u> | <u>H-3</u><br><u>(pCi/g)</u> |
|---------------|--------------------------------|-------------------------------|--------------------------------|------------------------------|
| 1-V-44        | < 1.0                          | 18.3                          | < 1.4                          | < 13.6                       |
| 2-V-44        | < 1.0                          | 27.3                          | < 1.4                          | < 13.6                       |
| 3-V-44        | < 1.0                          | 24.4                          | < 1.4                          | < 13.6                       |
| 4-V-44        | < 1.0                          | 24.6                          | < 1.4                          | < 13.6                       |
| 5-V-44        | < 1.0                          | 26.8                          | < 1.4                          | < 13.6                       |
| 6-V-44        | < 1.0                          | 20.6                          | < 1.4                          | < 13.6                       |
| 7-V-44        | < 1.0                          | 27.2                          | < 1.4                          | < 13.6                       |
| 10-V-44       | < 1.0                          | 33.8                          | < 1.4                          | < 13.6                       |



IX-2

Figure 1. MURR Environmental Program Sample Stations

NOTE: September 1983 City sewerage plants at stations 8 and 9 closed. All waste water now processed at City Waste Treatment Facility at station 10.

Determined Radioactivity Levels

Soil Samples

| <u>Sample</u> | <u>Alpha<br/>(pCi/g)</u> | <u>Beta<br/>(pCi/g)</u> | <u>Gamma<br/>(pCi/g)</u> |
|---------------|--------------------------|-------------------------|--------------------------|
| 1-S-44        | < 0.5                    | 18.6                    | 6.1                      |
| 2-S-44        | < 0.5                    | 19.6                    | 5.8                      |
| 3-S-44        | 0.7                      | 13.4                    | 5.1                      |
| 4-S-44        | 0.6                      | 5.8                     | 3.4                      |
| 5-S-44        | 0.7                      | 12.7                    | 5.0                      |
| 6-S-44        | < 0.5                    | 12.0                    | 5.5                      |
| 7-S-44        | < 0.5                    | 14.6                    | 5.7                      |
| 10-S-44       | < 0.5                    | 18.1                    | 6.0                      |

Determined Radioactivity Levels

Water Samples

| <u>Sample</u> | <u>Alpha<br/>(pCi/l)</u> | <u>Beta<br/>(pCi/l)</u> | <u>Gamma<br/>(pCi/l)</u> | <u>H-3<br/>(pCi/ml)</u> |
|---------------|--------------------------|-------------------------|--------------------------|-------------------------|
| 4-W-44        | 0.6                      | 12.6                    | < 200.5                  | < 13.6                  |
| 6-W-44        | < 0.5                    | 7.2                     | < 200.5                  | < 13.6                  |
| 10-W-44       | < 0.5                    | 16.3                    | < 200.5                  | < 13.6                  |

## ENVIRONMENTAL TLDs

The MURR Health Physics staff have continued to work with Landauer, Inc. in the development of a TLD monitoring program to monitor external doses around the MURR Facility. The table on the following page lists the results of monitors as they were deployed in 1993.

A design for the monitors has been determined, but their placement is still under development. All totals remained below 100 mrem/year, except monitor number 9. This monitor is located on the side of the MURR building near the loading dock where radioactive shipments are made. This monitor, along with the other five monitors that had readings greater than 25 mrem/year, were all located on the brick exterior of the building. A test during the first quarter in 1993 showed that a monitor mounted on a brick structure 65 meters from the reactor building recorded 15.1 mrem where its counterpart equidistant, but deployed in a tree, was 4.6 mrem.

Shipping and deployment controls are carried with each set and stored at a distant site. These are used to determine background which is subtracted from each of the monitors. This normalizes all of the monitors and compensates for any exposure they may experience in transit. Negative numbers on some of the monitors indicate that dose levels at the deployment site are not significantly different than background.

Environmental TLD Summary  
January through December 1993

| Badge Number | Direction From MURR | Map Distance from MURR Stack (meters) | 1st Qtr. 1993 Net mR | 2nd Qtr. 1993 Net mR | 3rd Qtr. 1993 Net mR | 4th Qtr. 1993 Net mR | Total 1993 Net mR |
|--------------|---------------------|---------------------------------------|----------------------|----------------------|----------------------|----------------------|-------------------|
| 1            | Control             | N/A                                   | -1.6                 | -1                   | -0.7                 | 0                    | -3.3              |
| 2            | Control             | N/A                                   | -1.4                 | -1.4                 | -0.9                 | 1.1                  | -2.6              |
| 3            | Control             | N/A                                   | -1.2                 | -0.8                 | -0.8                 | 4.6                  | 1.8               |
| 4            | Control             | N/A                                   | -1.1                 | -1                   | -1.8                 | 3                    | -0.9              |
| 5            | Control             | N/A                                   | -1.1                 | -1.7                 | -0.3                 | 1.2                  | -1.9              |
| 6            | NNE                 | 34                                    | 7.5                  | 10.9                 |                      | 9.8                  | 28.2              |
| 7            | ESE                 | 57                                    | 14.7                 | 22.2                 | 20.6                 | 22.2                 | 79.7              |
| 8            | WSW                 | 27                                    | 16.4                 | 19.6                 | 19.9                 | 39.1                 | 95                |
| 9            | SSE                 | 27                                    | 61.8                 | 86.2                 | 70.6                 | 56.8                 | 275.4             |
| 10           | NE                  | 149                                   | 0.8                  | 2.5                  | 0.5                  | -0.1                 | 3.7               |
| 11           | N                   | 149                                   | 2.8                  | 4.4                  | 3.5                  | 4.8                  | 15.5              |
| 12           | ENE                 | 301                                   | 3.9                  | 6.2                  | 6                    | 9.9                  | 26                |
| 13           | NNE                 | 316                                   | 2.3                  | 3.3                  | -4                   | 2.7                  | 4.3               |
| 14           | S                   | 156                                   | 4.3                  | 6.9                  | 2.7                  | 4.4                  | 18.3              |
| 15           | S                   | 65                                    | 15.1                 | 26.6                 | 18                   | 18.7                 | 78.4              |
| 16           | SE                  | 107                                   | 3.1                  | 8.8                  | 4.1                  | 1.4                  | 17.4              |
| 17           | E                   | 293                                   | 2.5                  | 5.3                  | 1.5                  | 0.1                  | 9.4               |
| 18           | NE                  | 476                                   |                      | 5.8                  | 3.1                  | 0.3                  | 9.2               |
| 19           | NNE                 | 606                                   | 3                    |                      | 4.1                  | 1.3                  | 8.4               |
| 20           | NE                  | 907                                   | 1.4                  | 4                    | 2.7                  | 1.3                  | 9.4               |
| 21           | SE                  | 236                                   | 1.2                  | 7.4                  | 2.6                  | 1.2                  | 12.4              |
| 22           | ESE                 | 168                                   | -1.6                 | 0.6                  | -0.8                 | -3.7                 | -5.5              |
| 23           | NW                  | 110                                   | 0.7                  | 2                    | 2                    | -0.1                 | 4.6               |
| 24           | SSW                 | 328                                   | -1.8                 | 0.6                  | 2                    | 0.1                  | 0.9               |
| 25           | SSW                 | 480                                   | 1.4                  | 4.5                  | 2.9                  | 1.4                  | 10.2              |
| 26           | SW                  | 301                                   | 3.7                  | 5.5                  | 4.1                  | 3.4                  | 16.7              |
| 27           | WSW                 | 141                                   | -1.3                 | -0.5                 | -0.4                 | -1.6                 | -3.8              |
| 28           | WNW                 | 210                                   | 3.4                  | 5.4                  | 4.1                  | 4.5                  | 17.4              |
| 29           | NW                  | 255                                   | 3.3                  | 4.7                  | 3.6                  | 5                    | 16.6              |
| 30           | NNW                 | 328                                   | 0.4                  | 3.9                  | 3.4                  | 2.6                  | 10.3              |
| 31           | NNE                 | 671                                   | 3.9                  | 2.9                  | 3.5                  | 5.1                  | 15.4              |
| 32           | NNW                 | 724                                   | 2.6                  | 9.9                  | 4.6                  | 2                    | 19.1              |
| 33           | E                   | 671                                   | -0.5                 |                      | 6.7                  | -1.3                 | 4.9               |
| 34           | ENE                 | 587                                   | -0.7                 | 1.7                  | 1.7                  | -0.1                 | 2.6               |
| 35           | SSE                 | 499                                   | 2.3                  | 2.2                  | 1.5                  | 2.9                  | 8.9               |
| 36           | SE                  | 419                                   | 2.2                  | 7.4                  | 5.5                  | 3.4                  | 18.5              |
| 37           | NE                  | 690                                   | -0.9                 | 0                    | -0.4                 | -3.1                 | -4.4              |
| 38           | NW                  | 556                                   | 3.9                  | 9.1                  | 5.8                  | 2.6                  | 21.4              |
| 39           | W                   | 491                                   | 4.1                  |                      | 7.1                  | 3.5                  | 14.7              |
| 40           | N                   | 514                                   | 1.6                  | 7.4                  | 5.4                  | 2.5                  | 16.9              |
| 41           | ENE                 | 137                                   | 3.4                  | 8.1                  | 4.3                  | 3.3                  | 19.1              |
| 42           | In Building         | N/A                                   | 15.8                 | 10.5                 | 10.6                 | 6.2                  | 43.1              |
| 43           | In Building         | N/A                                   | 7.2                  | 9.1                  | -4.7                 | 11.5                 | 23.1              |
| 44           | Distant Site        | N/A                                   | -0.9                 |                      | 0                    | -1.1                 | -2                |
| 45           | Distant Site        | N/A                                   | 4.6                  | 6.8                  | 5.3                  | 5.2                  | 21.9              |

## NUMBER OF FACILITY RADIATION AND CONTAMINATION SURVEYS

|             | <u>Radiation</u> | <u>Surface<br/>Contamination*</u> | <u>Air<br/>Samples</u> | <u>RWP</u> |
|-------------|------------------|-----------------------------------|------------------------|------------|
| <u>1993</u> |                  |                                   |                        |            |
| July        | 32               | 32                                | 32                     | 7          |
| August      | 27               | 27                                | 30                     | 7          |
| September   | 12               | 10                                | 29                     | 7          |
| October     | 36               | 34                                | 28                     | 9          |
| November    | 36               | 36                                | 30                     | 11         |
| December    | <u>51</u>        | <u>46</u>                         | <u>33</u>              | <u>8</u>   |
| TOTALS      | 194              | 185                               | 182                    | 49         |

\*Note: In addition, general building contamination surveys are conducted each normal work day.

### Miscellaneous Items

In January 1993 Dr. Susan M. Langhorst, Manager Reactor Health Physics, began a one year sabbatical with the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC) in Washington, DC. CIRRPC is a research committee responsible for advising Federal Agencies on Health Physics policy. Dr. Langhorst will return to MURR the first of March, 1994. Mr. John Ernst is Acting Health Physics Manager in her absence. September 1, 1993, Mr. F. Scott Keithly joined the group as a Health Physics Technician. Scott has over ten years experience as a Health Physics Technician in nuclear power plants and naval ship yards.

The University made application to the NRC for renewal of its Broad Scope Materials License on February 27, 1992. The renewal application asked for separate licenses for each of the four university campuses and for MURR. The NRC issued MURR a Broad Scope Materials License effective July 7, 1993.

ADCO Services continues to function as radioactive waste broker for MURR. Through ADCO we disposed of 270 cubic feet of LSA material during the second half of 1993.

The ALARA program implemented to document efforts to reduce personnel exposure continues to function. MURR personnel and other users of the Center are assigned to research or operational groups for the purpose of ALARA review. The average monthly whole body deep dose to individuals in each group are shown in the following table:

| <u>Group Name</u>                    | <u>Average Monthly Dose</u> |
|--------------------------------------|-----------------------------|
| Actinide Chemistry                   | 10 mrem                     |
| Computer Development                 | minimal                     |
| Electronic and Mechanical Properties | minimal                     |
| Director's Office                    | minimal                     |
| Facilities Operations                | 10 mrem                     |
| Gamma Ray Scattering                 | 10 mrem                     |
| Health Physics                       | 40 mrem                     |
| Instrument Development               | minimal                     |
| Magnetic and Crystal Structure       | minimal                     |
| Nanostructures and Excitations       | 10 mrem                     |
| Neutron Optics                       | 10 mrem                     |
| Nuclear Analysis Program             | minimal                     |
| Nuclear Archaeology and Geochemistry | minimal                     |
| Nuclear Engineering                  | minimal                     |
| Operations                           | 80 mrem                     |
| Radiobiochemistry                    | 10 mrem                     |
| Radiopharmaceutical                  | 10 mrem                     |
| Services Applications                | 20 mrem                     |

## SECTION X

### SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS, AND VISITORS

1 July 1993 through 31 December 1993

1. Largest single exposure and average exposure are expressed in millirem.
2. Minimal exposure is defined to be gamma <10 mrem; beta < 40 mrem; neutron < 20 mrem.
3. ME = Number of monthly units reported with minimal exposure.
4. AME = Number of monthly units reported with exposure above minimal.
5. AE = Average mrem reported for all units above minimal.
6. HE = Highest mrem reported for a single unit for the month.
7. Dosimetry services except for "Self Reading Dosimeters" are provided by R. S. Landauer, Jr. & Co.  
 Dosimeter Types: "C" - X, Gamma, Beta, Fast Neutron (Neutrak 144), Thermal Neutron; "G" - X, Gamma, Beta; "U" -TLD (1 Chip Ring).

#### **PERMANENT ISSUE BADGES**

##### **"C" Whole Body Badges (Deep Dose):**

|     | JUL | AUG | SEP | OCT | NOV | DEC |
|-----|-----|-----|-----|-----|-----|-----|
| ME  | 149 | 154 | 144 | 112 | 132 | 152 |
| AME | 58  | 51  | 55  | 98  | 73  | 54  |
| AE  | 59  | 63  | 61  | 47  | 63  | 83  |
| HE  | 160 | 210 | 180 | 210 | 190 | 250 |

##### **"G" Whole Body Badges (Deep Dose):**

|     | JUL | AUG | SEP | OCT | NOV | DEC |
|-----|-----|-----|-----|-----|-----|-----|
| ME  | 79  | 79  | 74  | 79  | 81  | 80  |
| AME | 3   | 3   | 5   | 7   | 2   | 4   |
| AE  | 20  | 30  | 20  | 14  | 15  | 20  |
| HE  | 30  | 50  | 50  | 30  | 20  | 30  |

##### **"U" TLD Finger Rings:**

|     | JUL | AUG | SEP | OCT | NOV | DEC |
|-----|-----|-----|-----|-----|-----|-----|
| ME  | 160 | 160 | 148 | 178 | 158 | 166 |
| AME | 84  | 74  | 89  | 72  | 86  | 79  |
| AE  | 138 | 115 | 111 | 124 | 136 | 147 |
| HE  | 570 | 510 | 490 | 420 | 710 | 600 |

SECTION X

SUMMARY OF RADIATION EXPOSURES TO  
FACILITY STAFF, EXPERIMENTERS, AND VISITORS (CONTD)

**Self Reading Dosimeters:**

|       | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|-----|-----|-----|-----|-----|-----|
| M E   | 4   | 10  | 18  | 8   | 11  | 13  |
| A M E | 111 | 117 | 93  | 104 | 105 | 109 |
| A E   | 44  | 27  | 44  | 46  | 44  | 50  |
| H E   | 214 | 207 | 183 | 222 | 186 | 279 |

**SPARE ISSUE BADGES**

**"C" Whole Body Badges (Deep Dose):**

|       | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|-----|-----|-----|-----|-----|-----|
| M E   | 60  | 71  | 72  | 64  | 66  | 69  |
| A M E | 60  | 3   | 2   | 10  | 9   | 3   |
| A E   | 150 | 10  | 180 | 25  | 26  | 47  |
| H E   | 170 | 10  | 180 | 60  | 120 | 80  |

**"G" Whole Body Badges (Deep Dose):**

|       | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|-----|-----|-----|-----|-----|-----|
| M E   | 61  | 61  | 62  | 61  | 61  | 61  |
| A M E | 0   | 0   | 1   | 0   | 0   | 0   |
| A E   | 0   | 0   | 60  | 0   | 0   | 0   |
| H E   | 0   | 0   | 60  | 0   | 0   | 0   |

**"U" TLD Finger Rings:**

|       | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|-----|-----|-----|-----|-----|-----|
| M E   | 32  | 37  | 32  | 35  | 30  | 35  |
| A M E | 16  | 10  | 6   | 3   | 8   | 3   |
| A E   | 113 | 164 | 110 | 43  | 90  | 63  |
| H E   | 250 | 340 | 250 | 60  | 190 | 70  |