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February 28, 1995

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

Enclosed are two copies of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers 1 January 1994 through 31 December 1994.

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

Sincerely,

Walt A. Meyer Jr.
Reactor Manager

bjb 030089

enclosures

xc: Document Control Desk, USNRC ✓

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UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

1 January 1994 - 31 December 1994

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

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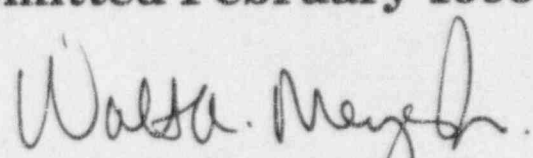
REACTOR OPERATIONS

ANNUAL REPORT

1 January 1994 - 31 December 1994

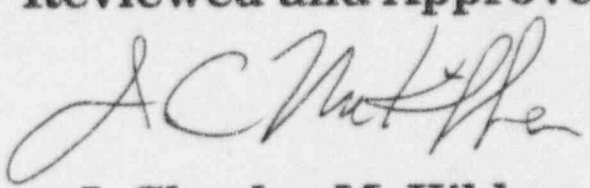
Compiled by the Reactor Staff

Submitted February 1995 by



Walt A. Meyer, Jr.
Reactor Manager

Reviewed and Approved



J. Charles McKibben
Associate Director

TABLE OF CONTENTS

SECTION I

REACTOR OPERATIONS SUMMARY
1 January 1994 through 31 December 1994

The following table and discussion summarizes reactor operations in the period 1 January 1994 through 31 December 1994.

Date	Full Power Hours	Megawatt Days	Full Power Percent of Total Time	Full Power Percent of Schedule*
Jan. 1994	669.63	279.24	90.00	100.80
Feb. 1994	583.22	243.09	86.79	97.20
Mar. 1994	673.99	281.01	90.59	101.46
Apr. 1994	648.15	270.20	90.02	100.82
May 1994	656.34	273.65	88.22	98.80
Jun. 1994	649.24	270.64	90.17	100.99
Jul. 1994	671.99	280.14	90.32	101.16
Aug. 1994	674.31	281.10	90.63	101.51
Sep. 1994	659.49	275.01	91.60	102.59
Oct. 1994	668.91	278.97	89.91	100.70
Nov. 1994	660.62	275.37	91.75	102.76
Dec. 1994	675.48	281.62	90.79	101.69
Total for one year period	7,891.37	3,290.04	90.08% of time for 12 mos. at 10 MW	100.89% of sched. time for 12 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 year.

There were fourteen unscheduled shutdowns recorded during the period 1 January 1994 through 31 December 1994. Of these unscheduled shutdowns, seven were scrams and seven were rod run-ins (RRIs).

Five of the unscheduled shutdowns were manually initiated scram or rod run-in to allow investigation and/or repair of various reactor equipment. The remaining nine unscheduled shutdowns were spurious in nature. Four spurious rod run-ins were associated with closing the Channel 4 (wide range) nuclear instrument drawer. Electronics technicians have investigated each case, but the source of the spurious RRIs is uncertain.

Two spurious scrams early in 1994 were attributed to the Trip Actuator Amplifier (TAA) associated with the reactor scram and rod run-in circuits. Since the trip point on each TAA was set to the same value in March 1994, no unscheduled shutdowns associated with the TAAs have occurred.

There were two Licensee Event Reports (LERs) submitted to the NRC in 1994. One in April regarding the regulating blade being inoperable for a period of 6 to 7 minutes and one in September regarding an airlock door failure resulting in a momentary loss of containment integrity. Neither of the events detailed in the LERs represented a safety concern to the reactor or the public.

The University of Missouri Research Reactor received two notices of violation by the NRC in 1994. One Notice of Violation was for apparent violation of 10CFR50.7, Employee Protection from Discrimination. A second Notice of Violation involved violation of 10CFR71.5(a) and applicable Department of Transportation regulations associated with radioactive material shipments. MURR sent a reply to the NRC for each violation describing the corrective actions being implemented to ensure these violations will not recur.

January 1994

The reactor operated continuously in January with the following exceptions: five shutdowns for scheduled maintenance and refueling; one unscheduled shutdown.

On January 18, a spurious reactor scram occurred during a normal startup when the safety system green leg TAA (serial #135) tripped, dropping control blades "C" and "D". This action initiated a "rod not in contact with magnet" rod run-in, causing control blades "A" and "B" to drive in. The yellow leg TAA (serial #137) did not trip. Both yellow and green leg TAAs were able to be reset, indicating that a true scram signal had not occurred in either leg. A valid scram signal will trip both TAAs because of the non-coincidence logic units (NCLU) that precede them. These NCLUs were tested to verify that a valid trip from either the yellow or green leg would initiate a scram from both TAAs. This was done by opening the contacts of the power level interlock relays in each leg.

The electronics technicians investigating this type of spurious scram found that the trip setting on the green leg TAA (serial #135) was about 1.2 volts higher than the yellow leg TAA (serial #137). They concluded that a high resistance in the series of contacts that comprise the green and yellow leg could result in an intermediate voltage level being applied to the TAA input [the input is normally full voltage (non-tripped) or zero voltage (tripped)] which could cause only the TAA with the higher trip point to trip. This determination was further supported by additional investigation after a similar unscheduled shutdown in March 1994. In order to gain additional information to isolate the source of the spurious scram, TAA (serial #135) was placed in the yellow leg of the safety system and a spare TAA (serial #138) was installed in the green leg of the safety system.

Major maintenance items for the month included: replacing the relief valve on the anti-siphon tank; replacing valve 527F (primary demineralizer isolation) air diaphragm and valve 527A (pressurizer drain) o-ring and valve diaphragm; and installing a spare TAA in the yellow leg of the safety system.

February 1994

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

Major maintenance items for the month included: performing Special Maintenance Procedure, SMP-31, removing the originally installed graphite reflector elements 2 and 3--through which beamports "B" and "C" extend, and replacing them with new reflector elements; removing the experimental cans from beamports "B" and "C" per modification package 94-1; removing the collimator in beamport "C"; replacing valve 565A (drain collection tank outlet) air operated diaphragm; and installing a bag-filter housing on the air pump inlet of the pneumatic tube operation system.

March 1994

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

On March 9, a spurious reactor scram occurred when the safety system yellow leg TAA (serial #135) tripped, dropping control blades "A" and "B". This action initiated a "rod not in contact with magnet" rod run-in, causing control blades "C" and "D" to drive in. The green leg TAA (serial #138) did not trip, indicating that a valid trip signal had not occurred on either safety leg. The yellow leg TAA (serial #135) was replaced by a spare TAA (serial #137). TAA (serial #135) was bench tested and found to have a trip setpoint 1 to 2 volts higher than the other TAAs. The non-coincidence logic units (NCLU) were satisfactorily tested to verify that a valid trip from either the yellow or green leg would initiate a scram from both TAAs.

The spurious scram was caused by higher than normal resistance in the series mechanical relays that comprise a voltage divider at the input to the NCLUs. A change in the series resistance of a number of relay contacts is not uncommon and depends on relay contact surface condition and spring tension, which can vary. A higher than usual resistance in the series contacts in this leg resulted in a voltage level applied to the input to both TAAs that was lower than the yellow leg TAA (serial #135) trip point but higher than the green leg TAA (serial #138) trip point.

Electronics technicians installed a spare TAA module in the yellow leg of the safety system and set the trip setpoint to match the green leg TAA. No further spurious scrams of this nature have occurred since that time.

On March 29, a spurious reactor isolation occurred when one of the two area radiation monitor modules for the air plenum did not detect a threshold number of input pulses from its detector. This automatically initiated a scram trip and reactor containment isolation. The Eberline area radiation monitors in use are designed to initiate an automatic alarm or trip (a protective feature in the event of detector failure) if the background radiation drops below the detectable range for a specified period of time (approximately one minute between input pulses). After conferring with Health Physics personnel, stronger background sources were placed inside the ARMS monitor boxes to ensure that the background radiation at the detectors remained in the detectable range. All personnel had exited the reactor containment building as required by procedure when the reactor isolation occurred. The reactor was subsequently restarted and no further problems of this type have occurred.

Major maintenance items for the month included: replacing solenoid valve 529D actuator for valve 527B (pressurizer charging); replacing the yellow leg TAA with a spare; installing a new breaker in the 120/240 V power distribution center dedicated to the electric forklift charger; replacing the scram trip lamps on pressure transmitters 944 A & B (core discharge) and 943 (primary).

April 1994

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

On April 26, 1994, the regulating blade drive mechanism was inoperable for a period of six to seven minutes. Operation of the reactor during this time deviates from Technical Specification 3.2.a. which states, "All control blades, including the regulating blade, shall be operable during reactor operation." A Licensee Event Report detailing this deviation from Technical Specifications and the corrective actions was sent to the NRC on May 26, 1994.

Major maintenance items for the month included: biennial change-out of control blade offset "B"; installing a new silicon wedge (with detectors) in the I/J position; replacing Beamport "A" liner; and replacing Beamport "F" centertube.

May 1994

The reactor operated continuously in May with the following exceptions: five shutdowns for scheduled maintenance and refueling and one shutdown for flux trap sample changes. The biennial emergency preparedness drill involving outside emergency support organizations was completed May 16, 1994.

Major maintenance items for the month included: replacing the outer personnel airlock door motor; replacing the primary T_c MV/I millivolt transmitter; adjusting the stop for the closed position indication for valve 543A (anti-siphon); modifying the regulating blade drive motor coupling by drilling a hole through one allen set screw and shaft and inserting a cotter pin; installing new exerciser timer in the emergency diesel generator; and replacing the primary demineralizer inlet conductivity meter.

June 1994

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

On June 13, a channel #4 high power rod run-in occurred when the channel #4 drawer chassis contacted the drawer stop while being pushed back into the instrument cabinet after adjusting the gain potentiometer. No actual high power was indicated on any instruments. Attempts to duplicate this event were unsuccessful. The rod run-in was subsequently reset and the reactor was returned to normal operation. Electronics technicians examined and tested the drawer on the next scheduled maintenance day and were not able to duplicate the problem. This problem recurred several additional times (July, October and December) in 1994.

On June 6, a waste shipment of irradiated metal hardware was shipped to and accepted by the facility at Barnwell, South Carolina.

Major maintenance items for the month included: replacing the regulating blade shaft coupling; replacing pool loop "B" GE type flow transmitter with a new Rosemount transmitter; repairing the diesel generator emergency shutdown switch; and replacing the scram trip light for primary pressure transmitter 943 meter relay trip unit.

July 1994

The reactor operated continuously in July with the following exceptions: five shutdowns for maintenance and refueling or flux trap changes; three unscheduled shutdowns.

On July 1, a manual scram was initiated when a small air leak was discovered in the inflatable sealing gasket of the outer personnel airlock door. The leak was not on the seating surface of the gasket and was so small that sealing pressure stayed within its normal operating limit and containment integrity was not compromised. The gasket was replaced and tested satisfactorily and the reactor was refueled and returned to normal operation.

On July 29, a manual scram was initiated when the leading edge hanger bolt on the inner personnel airlock door sheared, rendering the door inoperable. As part of the normal operating sequence, the outer personnel airlock door was closed and sealed at the time the inner door hanger bolt failed. Containment isolation was not lost while the reactor was operating. The bolt was replaced and the door was tested satisfactorily. The reactor was then refueled and returned to normal operation.

On July 30, a spurious rod run-in occurred simultaneously with pushing the NI channel #4 drawer back into the instrument cabinet after adjusting the gain potentiometer. There were no unusual or abnormal readings indicated on any instrumentation prior to or after this occurrence. The rod run-in was reset and, while subcritical, an attempt to duplicate the rod run-in by opening and closing the channel #4 drawer was unsuccessful. The cause was determined to be spurious, but coincident with the physical movement of the channel #4 drawer. Electronics technicians investigated this problem during the following maintenance day, August 1, but could not reproduce the spurious rod run-in.

Major maintenance items for the month included: replacing the inflatable sealing gasket on the outer personnel airlock door; replacing the pressurizer high pressure alarm switch (PS 946); installing a new evacuation horn and light in laboratory #215; replacing the diaphragm and inlet and outlet flexitallic gaskets on primary valve 540A; and replacing the leading edge hanger bolt on the inner personnel airlock door.

August 1994

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

Major maintenance items for the month included: replacing one of the two lower guide springs on the inner personnel airlock door; removing the Nuclepore irradiator case to shielded storage; and replacing the resin in the fission product monitor.

September 1994

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

On September 2, a manual scram was immediately initiated upon the discovery of the failure of the inner personnel airlock door drive mechanism. The door drive chain became detached from the door when the coupling that attaches it to a shock

absorber became unthreaded, rendering the door inoperable, and ultimately causing a momentary loss of containment. The chain coupling was rethreaded and subsequently has been modified to include a 1/8" roll pin to prevent a recurrence of this type of failure. A letter to the Director of Nuclear Reactor Regulation was sent on September 30 describing this incident and corrective actions taken.

On September 12, a manual rod run-in was initiated during a normal startup when erratic indications were noted on NI channel #2 (intermediate range monitor). Electronics technicians investigated and isolated the problem to the signal connector within the drawer. The suspected connector was cleaned and the drawer was placed back in service and tested satisfactorily. The startup was completed and no further problems of this type have recurred.

On September 27, a spurious rod run-in occurred with no abnormal or unusual indications on any instrumentation. The rod run-in was reset and the rod run-in trip actuator amplifier (TAA) was manually tripped and reset satisfactorily to test its operation. Reactor power was subsequently recovered. On the next scheduled maintenance shutdown (October 3), electronics technicians replaced the rod run-in TAA with a spare to help isolate the source of the spurious rod run-in should it recur.

Major maintenance items: removed the south side pneumatic tube biological shield penetration section, and blank flanged or sealed off the open sections; and repaired inner personnel airlock door drive chain.

October 1994

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

On October 18, a spurious rod run-in occurred coincident with closing the wide range (channel #4) monitor drawer after completing a routine gain potentiometer change. No abnormal or unusual indications were noted on any instrumentation--other than the 95% downscale alarm on the annunciator. The rod run-in was subsequently reset and the reactor was returned to normal operation. On the following maintenance day (October 24), electronics technicians thoroughly inspected the wide range monitor drawer components and cable connections. Any suspect cable or lead connection was re-soldered.

Major maintenance items for the month included: installing a spare rod run-in trip actuator amplifier; replacing the inner personnel air-lock door gear box; correcting a mismatch in air flow between the dispatch and return modes of the pneumatic tube operating system; completing the biennial preventive maintenance replacement of control blade offset mechanism "D".

November 1994

The reactor operated continuously in November with the following exceptions: five shutdowns for scheduled refueling and/or maintenance; one unscheduled shutdown.

On November 21, a spurious rod run-in occurred from nuclear instrument channel #4 (wide range monitor) coincident with momentarily turning off its chart recorder. The chart recorder was immediately turned back on and the rod run-in was reset and reactor power was quickly restored. No actual high power condition occurred.

Major maintenance items for the month included: replacing an alarm relay on the Uninterruptible Power Supply; installing a new isolation valve on the secondary P-4 line; replacing a piping elbow on 10" secondary line to primary heat exchanger 503B; replacing o-rings in the actuator for the primary outlet isolation valve, 507B; replacing the microswitch for the wide range monitor (channel #4) recorder "greater than red set-point" in the regulating blade automatic control prohibit circuit; and unloading depleted pool deionization resin bed "R"--loading new pool resin bed "E".

December 1994

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

On December 16, a manual scram was initiated when the inner personnel airlock door closed on a transfer cart, wedging the cart between the door and the door frame, and temporarily rendering the door inoperable. The outer airlock door remained closed with its seal inflated to maintain containment integrity until after the reactor was shutdown and secured.

The inner airlock door was subsequently opened manually and the cart was removed. The inner airlock door and its safety edge were inspected and tested for operability and were determined to be operating satisfactorily. The reactor was then refueled and returned to normal operation.

On December 12, a spurious rod run-in occurred coincident with closing the wide range monitor (channel #4) drawer after completing a routine gain potentiometer change. No abnormal or unusual indications were noted on any instrumentation. The rod run-in was subsequently reset and the reactor was returned to normal operation. The precise cause for the rod run-in has not been determined. Electronics technicians have continued to investigate this type of spurious rod run-in.

Major maintenance items for the month included: replacing bearings and mechanical seal on pool demineralizer pump 513B; replacing inboard and outboard motor bearings on pump 513B; and replacing the room 114 exhaust absolute filters.

SECTION IA

CHANGES TO THE TECHNICAL SPECIFICATIONS
1 January 1994 through 31 December 1994

MURR TECHNICAL SPECIFICATIONS
(Manual issued 7/9/74)

Revision Number 8
Amendment Number 25
Amendment Date: 3/2/94

Section Number	Page Number
6.1	6 of 8

SUBJECT: Administration (continued)

reactor safety system from performing its safety function as described in the Technical Specifications. For each such occurrence, the University of Missouri shall notify within 24 hours, by telephone or telegraph, the Director of Regulatory Operations and shall submit within ten (10) days a report in writing to the Directorate of Licensing, with a copy to the Directorate of Regulatory Operations.

(2) The Directorate of Licensing shall be informed in writing within thirty (30) days of its observed occurrence any substantial variance disclosed by operation of the reactor from performance specifications contained in the Hazards Summary Report or the Technical Specifications.

(3) The Directorate of Licensing shall be informed in writing within thirty (30) days of its occurrence any significant changes in transient or accident analysis as described in the Hazards Summary Report.

(4) An annual report on reactor operation due 60 days following each **calendar**] year to include:

(a) A brief narrative summary of (1) operating experience (including operations designed to measure reactor characteristics), (2) changes in facility design, performance characteristics and

MURR TECHNICAL SPECIFICATIONS

(Manual issued 7/9/74)

Revision Number 9

Amendment Number 27

Amendment Date: 11/4/94

Section Number	Page Number
3.3	2 of 5
3.3	3 of 5
4.4	1 of 3

SUBJECT: Reactor Safety System (continued)

Pool Coolant Flow	2	1	0	425[4] gpm (Min) for each 50% capacity heat exchanger leg
		or		
	2	2	0	850[4] gpm (Min) for one 100% capacity heat exchanger
Differential Pressure Across Reflector	1	0	0	2.52 psi (Min) 8.00 psi (Max)
Differential Pressure Across Reflector	0	1	0	0.63 psi (Min) 2.00 psi (Max)
Differential Pressure Across Core	1	0	0	3200[5] gpm (Min)
Differential Pressure Across Core	0	1	1[2]	1600[5] gpm (Min)
Pressurizer High Pressure	1	1	1[2]	95 psia (Max)
Pressurizer Low Level	1	1	1[2]	16 inches below centerline (Min)
Pool Level	0	0	1	23 feet (Min)
Primary Coolant Isolation Valves 507A/B Off Open Position	1	1	1[2]	Either valve Off Open Position
Pool Coolant Isolation Valve 509 Off Open Position	1	1	0	Valve 509 Off Open Position
Power Level Interlock	1	1	1	Scram as a result of incorrect selection of operating mode
Facility Evacuation	1	1	1	Scram as a result of actuating facility evacuation system
Reactor Isolation	1	1	1	Scram as a result of actuating reactor isolation system

SUBJECT: Reactor Safety System (continued)

Manual Scram	1	1	1	Push Button at Control Console

(1) Flow orifice or heat exchanger ΔP (psi) in each operating heat exchanger leg corresponding to the flow value in the table.

(2) Not required below 50 KW operation if natural convection flange and pressure vessel cover are removed or in operation with the reactor subcritical by a margin of at least 0.015 ΔK.

(3) Trip pressure is that which corresponds to the pressurizer pressure indicated in the table with normal primary coolant flow.

(4) Flow orifice ΔP (psi) corresponding to the flow value in the table.

(5) Core ΔP (psi) corresponding to the core flow value in the table.

Bases

a. The specifications on high power, primary coolant flow, primary coolant pressure, and reactor inlet temperature provide for the safety system settings outlined in specifications 2.2.a, 2.2.b, and 2.2.c. In Mode I and II operation the core differential temperature is approximately 17°F

TECHNICAL SPECIFICATION

UNIVERSITY OF MISSOURI
RESEARCH REACTOR FACILITY

SUBJECT: Reactor Coolant System

Applicability

This specification shall apply to the reactor coolant systems.

Objective

It is the objective of this specification to assure proper coolant for safe operation.

Specification

a. The reactor coolant system shall consist of not less than a reactor pressure vessel, two primary system pumps, primary pressurizer, two primary heat exchangers, two pool system pumps, one 100% capacity or two 50% capacity pool system heat exchanger(s), and one pool system hold-up tank plus all associated piping and valves.
b. The reactor coolant system shall have one secondary coolant system capable of continuous discharge of heat generated at the operating power of the reactor.
c. The pumps and heat exchangers in the primary system shall constitute two parallel systems separately instrumented to permit safe operation at five megawatts on either system or ten megawatts with both systems operating simultaneously.

SECTION II

MURR PROCEDURES

1 January 1994 through 31 December 1994

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. 12, dated 1/6/94

Revision No. 13, dated 10/20/94

B. CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

(Dated January 1985; Revised and reprinted May 13, 1988)

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

Revision No. 15, dated 4/4/94

Revision No. 16, dated 7/29/94

Revision No. 17, dated 8/25/94

Revision No. 18, dated 12/20/94

C. CHANGES TO HEALTH PHYSICS STANDARD OPERATING PROCEDURES

Note: New manual issues 10/29/90

HP-6, Revision No. 1, dated 6/2/94

HP-13, Revision No. 1, dated 6/2/94

HP-17, Revision No. 4, dated 6/2/94

HP-35, Revision No. 1, dated 6/2/94

HP-28, Revision No. 2, dated 6/8/94

HP-39, Revision No. 0, dated 6/10/94

HP-28, Revision No. 3, dated 8/12/94

HP-39, Revision No. 1, dated 8/12/94

HP-14, Revision No. 2, dated 11/29/94

HP-5, Revision No. 1, deleted 6/2/94

HP-16, Revision No. 12, deleted 6/2/94

HP-23, Revision No. 2, deleted 6/2/94

HP-26, Revision No. 1, deleted 6/2/94

D. CHANGES TO MURR SHIPPING PROCEDURES:

SAS-0, Revision No. 1, dated 27 Sep 94

SAS-4, Revision No. 1, dated 14 Apr 94

SAS-4, Revision No. 2, dated 27 Sep 94

SAS-4, Revision No. 3, dated 4 Nov 94

STANDARD OPERATING PROCEDURES

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

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

Revision Number 12

Revision Date: 1/6/94

Page Number	Page Number
SOP/I-10	REP-21-1
SOP/II-2	REP-21-2
SOP/VI-6	
SOP/VI-7	SOP/A-1a
SOP/VII-19	SOP/A-1c
SOP/VII-21	SOP/A-11a
SOP/VII-22	SOP/A-19c
SOP/VII-23	SOP/A-19d
SOP/VII-24	
SOP/VII-25	
SOP/VII-26	
SOP/VII-27	
SOP/VIII-23	

calculation will normally be used to establish the 10 MW power level, however, the nominal steady state power level shall not exceed 10 MW. The reactor shall not be operated at a power level which causes the steady state secondary calorimetric to exceed 10.5 MW unless it is confirmed that the secondary calorimetric is in error or out of commission.

The primary system DI flow bypasses the core and yet it flows through the primary flow orifice. Therefore, the primary flow as read on the recorder should be decreased by the primary DI flow before the value is used in calculating the power level. The recorder values should be logged on the log sheets without correction.

I. Steady state reactor powers of 1 MW and greater will be determined by the method stated above. The power indicated by Channels 4, 5, and 6 shall be maintained greater than 100% **(and typically less than 105%)** during steady state full power operation. Channels 4, 5, and 6 are adjusted by proper positioning of the drawer amplifier feedback potentiometers. After adjustment of a potentiometer, the change in indicated power shall be logged in the console log and the new pot setting logged on the Startup Nuclear Data Sheet. The Shift Supervisor's approval must be obtained before adjustment of any Power Range Monitor. Adjustments shall be made after a determination of the power level by heat balance, with one exception. During or shortly after a normal reactor startup, and at the Shift Supervisor's discretion, the pot adjustments may be made when an accurate heat balance is not yet possible due to changing temperatures. In all cases, the Shift Supervisor must ensure that the pots are adjusted only in the conservative direction, that is, in a direction that over estimates actual power.

J. Minimum nuclear instrumentation for normal operation shall be two (2) intermediate range channels with period trip, two (2) power range channels each with high flux trips, and one (1) wide range channel with high flux trip.

K. Bring the reactor critical at a steady state power level of approximately 50 kW unless a lower power level is desired for tests, calibration runs, etc. The lowest steady state power level reached, and any ensuing steady state power, will be logged on the Startup Nuclear Data Sheet for a record of reactor operating time.

L. Withdraw the fission chamber to full out.

M. Verify that all nuclear instrumentation is responding normally.

N. Take a complete set of nuclear data on the Startup Nuclear Data Sheet. Indicate on this sheet the critical control and reg blade positions and the primary and pool temperatures.

O. Continue the startup, withdrawing only one blade at a time until the reactor power is increasing at no less than a 30 second period. At power levels greater than 100 kW, maintain the control blades such that the maximum difference in position between any two blades always remains less than 1 inch.

P. As the reactor power level approaches 1 MW, increase the period until a stable period remains that is no less than 100 seconds for all power increases greater than 1 MW.

Q. Bring the reactor critical at a steady state power level of 5.0 MW for mode I (10 MW) operation. At this power level:

1. Verify that the nuclear instrumentation is in essential agreement with the actual power level which can be read out directly from the digital calorimetric meter. Ensure that the steady state power level is maintained long enough for the digital calorimetric meter indication to stabilize (at least five (5) minutes). Note the actual power level in the operations console log book. In the case of the calorimetric meter being out of commission during a startup, the power level **should** be determined by manual calculation.

2. Note the time of arrival and departure from this power level on the Nuclear Startup Data Sheet.

R. Continue the reactor power increase by withdrawing only one control blade at a time, maintaining the reactor period at no less than 100 seconds.

VI.3.3 Winter Operations (Temperatures Expected Below Freezing)

Due to the potential for ice to significantly damage the plastic fill, every precaution must be exercised to prevent ice build-up on the wooden louvers and in the plastic fill.

When the cooling tower is to be left unattended for an extended period of time and there is a possibility of significant ice build-up, perform the following steps to prevent ice build-up in the plastic fill:

1 Open or verify open the basin steam supply valve.

2. Verify the steam solenoid valve operable.

3. Secure CT makeup automatic valve.

4. Prop open CT basin float valve to drain water between automatic valve and float valve.

5. Verify the CT makeup line heat tape is attached and operable.

6. Secure air conditioning unit and tag.

7. Secure P-4 and tag.

In certain instances, some of these steps may be omitted at the discretion of the shift supervisor.

VI.3.4 Cold Weather Operation of P-4 Flow Distribution]

If the reactor is shutdown when the outside temperature is below 40°F and P-4 is in operation, the P-4 flow distribution should be rerouted to the south bay of C.T. cell #1. This should be accomplished as soon as possible after shutdown.]

This will help prevent both ice build-up within the cooling tower and a cold temperature shutdown of the LiBr air conditioner. The LiBr air conditioner initiates an automatic shutdown on chill water temperature of 36°F.]

To reroute the flow:]

1. **Open valve S-47A**]
2. **Shut valve S-47B**]

After a reactor startup, to restore normal flow distribution:]

1. **Open valve S-47B**]
2. **Shut valve S-47A**]

VI.3.4 Cold Weather Operation of P-4 Flow Distribution (cont'd)]

Normal flow distribution should be restored as soon as possible after a startup to restore flow past the conductivity probe. After restoring normal flow distribution, open the line drain valve (S-196) enough to prohibit freezing (valve located in bay 1).]]]]

VI.4 Shutdown of the Secondary System

Upon completion of shutdown of the reactor, reactor primary and pool loop cooling systems. the secondary cooling loop can be shutdown as follows:

A. Shutdown secondary pump or pumps. If more than one secondary pump is operating, they should be secured simultaneously to minimize check valve slam. This is done from the control room instrument panel.

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, micro-biological growth, and other major chemical problems which are present in the secondary cooling water system.

VI.6.2 Secondary Water Conductivity Control **and pH Control**]

Descriptions of these systems are in the MURR Training Manual.]

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.6.3 System Startup

The primary/pool drain collection system should be in operation anytime evolutions involving operation of reactor or pool water systems are being performed. The following steps will prepare the system for operation:

A. Turn on the panel control power located behind the instrument cubical.

B. Place the valve operating system (air/N_2) in-service as per Section **VII.10.1.**]

C. Verify that the pool level is sufficiently below the overflow so that water from the collection tank will not overflow the pool when pumped.

VII.6.4 System Shutdown

After all systems have been secured and the building shutdown check is in progress:

A. Verify that the level of the pool is low enough to accept water for the collection tank. If the pool level must be lowered, do so in accordance with Section VII.5.2.

B. Manually pump the water in the collection tank to its low level cutout as per Section VII.6.2.

C. Secure the valve operating system as per Section **VII.10.1.**]

D. Secure the electrical power to the control power panel by opening the switch behind the instrument panel.

VII.7 Primary and Pool Sample Station

VII.7.1 Sampling Frequency

Both the primary and pool influent waters are sampled on a weekly basis, and an activation analysis is conducted by the laboratory section for evidence of fission products and any activation products.

VII.8.1 Liquid Waste Disposal System Description (cont'd)

B. The WT system consists of two collection sumps, two sump pumps in each sump, one "Y" strainer, three waste tanks, two waste tank pumps, a filter bank and associated piping, valves and fittings.

C. Each WT has valved drains which connect via a common suction header to the waste tank pumps. This header also has connections for chemical addition, DCW, and LP air.

D. The waste pumps should always discharge through the Cuno filters to any waste tank or to the sanitary sewer system. The discharge header has a pressure gauge on both sides of the filter, a sample line, and a low pressure pump cutout switch (set at 5 psig). The low discharge pressure cutout switch automatically shuts off the running pump upon low discharge pressure.

E. Each tank has a sight glass for level readings. An air **sparge** line is installed along the entire length of WT1 and 2. Each tank has an unvalved vent to atmosphere. WT3 **(and WT1, if needed)** can receive waste directly from the hot waste sumps, depending on the valve line-up. **Each** tank **has** sludge settlement standpipes, but the normal sump discharge is to WT3. WT2 receives effluent directly from the DI200 regeneration system.

VII.8.2 Dry Active Waste

We must make every effort to remove as much waste as possible in the form of dry active waste. We have three methods:

(1) Sludge Settlement
(2) Cuno Filters
(3) Chemical Precipitant Treatment

A. Sludge Settlement

WT1 and WT3 are fitted with gravity drains to WT2 through 18" standpipes. This **can** allow WT1 or WT3 to act as settling tanks, **although only WT3 is currently used as a settling tank.** When the sludge buildup warrants, the sludge is dumped via a 3" drain line at the south end of WT3 (or the north end of WT1) into barrels or drying troughs. This sludge is dried and removed as dry active waste.

VII.8.2 **Dry Active Waste (cont'd)**

B. Cuno Filters

The waste water will normally be pumped through a waste system filter bank. When the ΔP is high across them, they are replaced with new filters, and the old ones are disposed of as dry active waste. See Section VII.8.11.

C. Chemical Precipitant Treatment

Radioactive particulates will attach themselves to carriers which can then be readily filtered out of the WT water. Without these carriers, even the most efficient filters could not remove this radioactive particulate. After filtering, the filters are shipped as dry radioactive waste. See **SMP-33**.

VII.8.3 Dumping Criteria

A. The liquid waste is collected and held until an analysis is made to determine that the specific activity of all radioactive isotopes in the waste is less than the limit specified in the Code of Federal Regulations, Title 10, Part 20 (10CFR20) for dumping liquid waste to the sanitary sewer. In addition to the dumping limit on each isotope, **10CFR20.2003** also limits the total activity which the **MURR** can dump to the sanitary sewer to 1 curie per year for carbon-14, 5 curies per year for H-3 (tritium), and 1 curie per year for other radioactive material, excluding C-14 and H-3. MURR **will continue to use** 80% of the **total** limit **as an administrative limit,** i.e., 800 millicuries per year for carbon-14, 4 curies per year for H-3 (tritium), and 800 millicuries per year of other radioactive material. This latter limit, and a general desire to minimize the activity dumped to our environment, dictates that the waste be retained as long as possible to permit the activity to decay off prior to discharge. If the 10CFR20 limits are not exceeded and the total activity of radionuclides does not exceed 10 mCi of tritium of 2 mCi of other nuclides, the Shift Supervisor may authorize the water to be pumped to the sanitary sewer. Any tank containing water with an activity greater than 10 mCi of tritium or 2 mCi of other nuclides will be discharged only with the approval of the Reactor Manager.

VII.8.3 **Dumping Criteria (cont'd)**]

B. When the liquid waste exceeds the limits of 10CFR20 for dumping, one of two methods will usually be utilized to dispose of the waste. The most desirable option is to retain the water until the activity has decayed off to permit dumping. The second option is to chemically treat the waste with a carrier solution that causes the radionuclides to precipitate which facilitates them being filtered out **(see SMP-33)**. Precipitates] will then be removed either by pumping from one tank to another or recirculating the tank through the WT filters. As the filtering process proceeds, it may be necessary to change the filters to a smaller mesh size and continue the filtration until the desired activity reduction is achieved.

C. It shall be standard procedure to hold all liquid waste as long as practical to minimize the total activity released. A sample of the tank is taken and delivered to Reactor Chemistry Group. Results of the analysis are recorded on the Waste Tank Sample Form and the form is sent to the Shift Supervisor. The Shift Supervisor reviews the sample results and makes the decision of what to do with the tank. If the Shift Supervisor decides to dump the tank, he sends the form to Health Physics for their concurrence. If Health Physics concurs that the tank can be dumped, the tank is pumped to the sanitary sewer as per Section VII.8.7. After the operator has completed pumping the tank, he enters the final volume pumped on the sample form and sends the form to Health Physics Department.

D. If the analysis of WT2 exceeds the 10CFR limits, or if the Shift Supervisor wishes to hold the tank for further decay, WT2 can be pumped to WT1 via the filters, utilizing a vigorous air sparge. Then WT1 shall be sampled at a later date and re-evaluated to determine where it should be dumped.

VII.8.4 Draining WT1 and WT2 **(not currently done; procedure moved to SMP-33)**]]

VII.8.5 **Transferring WT3 to WT2 (by Draining or Pumping if Necessary)**

NOTE: The new 10CFR20 prohibits visible settled solids in any sample, therefore, all waste tanks will be filtered through (5 micron) filters prior to sampling as reflected in this procedure.

When WT3 is nearly full, transfer it to WT2 via the standpipe.

A. Check valves **WD1 and WD2 and valves** W1A, 1B, 2A, 2B, 3B, **5, and** 9 shut.

B. Open valves 3A, **9, 16, 18, and 24.**

C. **Start pump #1, if necessary.**

D. **Upon completion, close valves 3A, 9, 16, 18, and 24.**

E. Record the evolution in the Reactor Log.

VII.8.6 Recirculating and Sampling of Waste Tanks

NOTE 1: Notify Reactor Chemistry group before obtaining a sample.

NOTE 2: Always pump through the filters by opening valves W16 and W18, ensuring W5 is closed. Before recirculating any tank, check the following valves closed: W1A, 1B, 2A, 2B, 3A, 3B, 5, 7, 8, 9, 22, 23, 24, 25, 26, 27,38, WD1, WD2, WD3, WD4, WD5.

If WP2 is used instead of WP1, open W7 and W8 instead of W9.

A. Sampling WT2

1. Open W2A, 2B, 9, 16, 18, 24.
2. Start waste pump (WP1) and verify flow.
3. Commence a vigorous air sparge through W2C.
4. Recirculate for 30 minutes prior to sampling.
5. Draw off a sample through W22 and discard to liquid waste drain.
6. Draw off a second sample through W22 for analysis.

NOTE: If sample shows indication of suspended solids or settled solids, additional recirculation and sampling is required.

VII.8.6 A. **Sampling WT2 (cont'd)**]

7. Shut W22 and secure the waste pump.

8. Close W2A, 2B, 2C, 9, 16, 18, 24.

9. Deliver the sample and completed sample form to the Reactor Chemistry Group for analysis.

10. Record taking of sample in the Reactor Log.

B. Sampling WT1 **(not currently done; procedure moved to SMP-33)**]

VII.8.7 Pumping to Sanitary Sewer

NOTE: Can be done only with Shift Supervisor's or Reactor Manager's authorization. Check the following valves closed: W1A, 1B, 2A, 2B, 3A, 3B, 5, 22, 23, 24, 25, 26, 27, 38. If pumping with WP2, open W7 and 8 instead of W9.

A. Pumping WT1 to Sewer **(not currently done; procedure moved to SMP-33)**]]

B. Pumping WT2 to Sewer

1. Open W2B, 9, 16, 18, WD1, WD2.

2. Commence a vigorous air sparge through W2C.

3. Start the waste pump (WP1) and verify flow.]

4. Check waste tank periodically until tank is empty. When empty, secure waste pump.

5. Shut W2B, 2C, 9, 16, 18, WD1, WD2.

6. Record the volume pumped on the Waste Tank Sample Form and return it to Health Physics Office.

7. Record the pumping evolution in the Reactor Log.

VII.8.8 Pumping Waste System to Secondary System (moved to SMP-15)

VII.8.9 Pumping Waste from One Waste Tank to Another

A. Pumping WT2 to WT3

1. Check closed valves W1A, 1B, 2A, 2B, 3A, 3B, 5, 23, 24, 25, 26, 38.

2. Check WT3 to **ensure** that it has enough room to accept the volume of WT2.]

3. Open W2A to pump via the standpipe or W2B to pump the entire contents of the waste tank. Open W9, 16, 18, 27.

4. Start the waste pump (WP1) and verify flow.]

5. Commence a vigorous air sparge through W2C. (Except if via standpipe).

6. When the waste tank is empty, shut W2C, 9, 16, 18, 27.

7. Record the pumping evolution in the Reactor Log.]

B. Pumping Waste Tank 2 to Waste Tank 1 (**not currently done; procedure moved to SMP-33**)]]

VII.8.10 Dumping Sludge from a Waste Tank

Sludge will be dumped from WT1 through valve W44 (WT2 through sludge plug, and WT3 through **W3D**) into barrels or troughs by a procedure approved by the Shift Supervisor. This sludge will be dried and disposed of as Dry Active Waste.]

VII.8.11 Changing Waste Tank Filters

A. Obtain Shift Supervisor's permission.

B. Wear gloves, lab coat, and shoe covers.]

C. Ensure all normally closed WT valves are closed.]

D. Place the filter drain line hoses in the floor drain. Open drain valve 51 and open the vent valve on housing.]

E. When water quits running, remove filter canister and place old filters in bucket.]

F. Replace filters and hardware, reassemble canister, and close valve 51.]

VII.8.11 **Changing Waste Tank Filters (cont'd)**

G. Open DCW valve 38 and valves 9 and 16 to fill and vent **filter canister**. Close vent valve.

H. Secure valves 9, 16, and 38.

I. Wash down area, dispose of collected filters in the drying rack.

J. Check self on **portal** monitor.

K. Notify Health Physics to survey area.

VII.8.12 Chemical Precipitate Treatment (**moved to SMP-33**)

VII.9 Nitrogen System

VII.9.1 Purpose

The primary function of the Nitrogen System (N_2) is to provide pressurized N_2 to the pressurizer to maintain primary pressure.

VII.9.2.1 N_2 System Startup

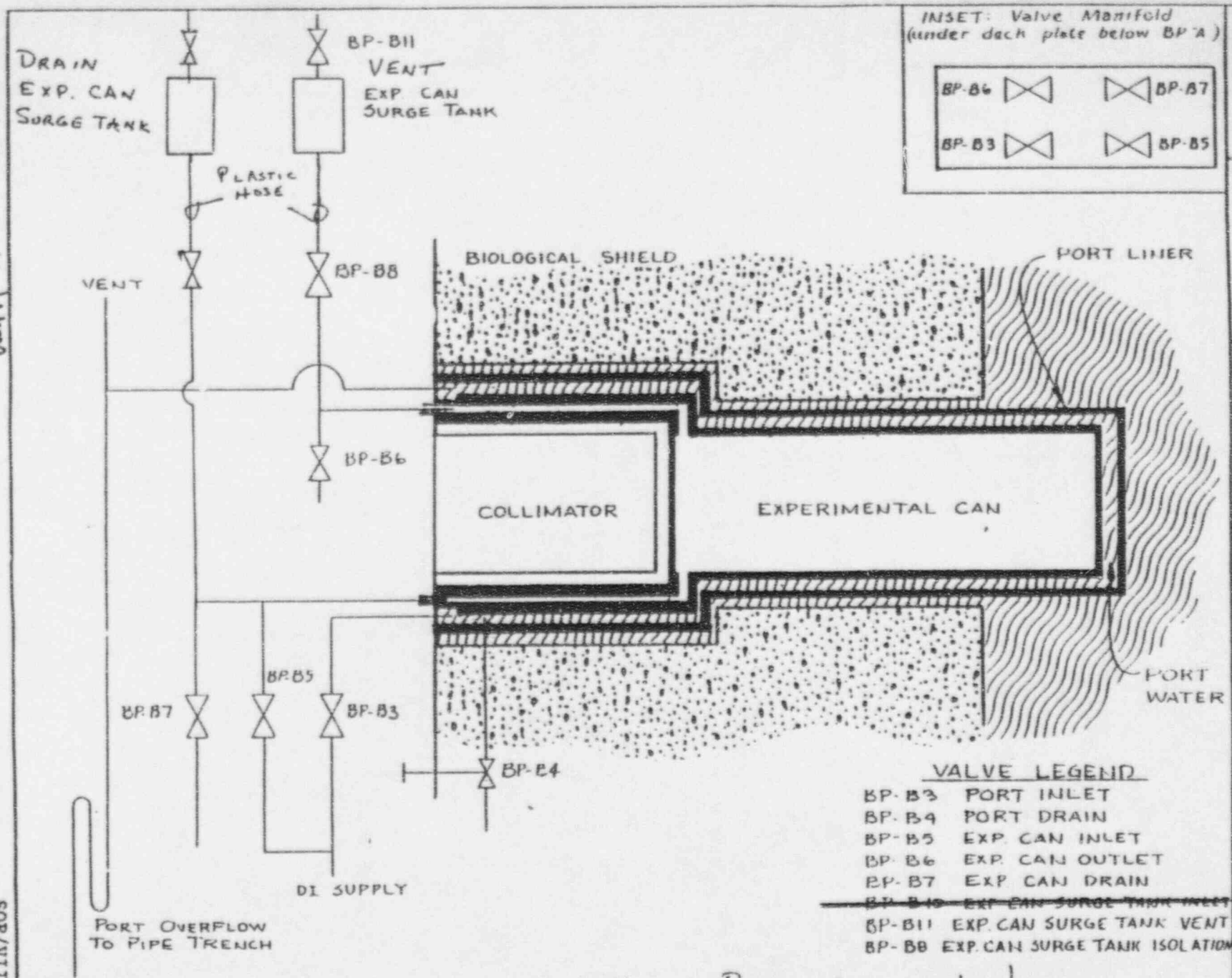
Before the reactor is made operational, light off the N_2 system by the following procedure:

A. Verify that the regulator is set at 140 psig and the average gauge pressure of the two N_2 banks is at least 500 psig before placing the system in operation.

B. Close the switch which energizes the electrical controls for the system.

C. Open the N_2 cut out valve N15 in room 114, and verify a N_2 pressure of 90 to 95 psig to the pressurizer.

The N_2 system is now ready for operation.



VALVE LEGEND

BP-B3	PORT INLET
BP-B4	PORT DRAIN
BP-B5	EXP. CAN INLET
BP-B6	EXP. CAN OUTLET
BP-B7	EXP. CAN DRAIN
~~BP-B10~~	~~EXP. CAN SURGE TANK INLET~~
BP-B11	EXP. CAN SURGE TANK VENT
BP-B8	EXP. CAN SURGE TANK ISOLATION

NOTE: PIPING AS OF 11/23/93
DRAIN EXP. CAN ADDED.

Rev. 1/6/94 App'd WDM

SOP/VIII-23

TITLE VALVE ARRANGEMENT BEAM PORT "B"			
RESEARCH REACTOR FACILITY UNIVERSITY of MISSOURI, COLUMBIA			
DATE 21 JUNE 1988	DRAWN BY J.M. McREE	APPROVED BY WDM	SCALE not to scale
SHEET 1 OF 5			DRAWING NO. 1887

REP- 21
HIGH STACK MONITOR INDICATIONS

IMMEDIATE ACTIONS:

1. Notify the Shift Supervisor.

2. Notify the Manager of Health Physics. After working hours contact: HEALTH PHYSICS CALL LIST.

SUBSEQUENT ACTIONS:

Evaluate the extent of iodine, particulate, and gas with **overlays**. If the extent of radioactivity is great enough to enter event classifications, the highest category of event indicated by gas, iodine or particulate reading will be used to classify the event.

The overlay thresholds assume the present release rates will be constant for a 24 hour period. They are conservative, since the present release rate may exist for less than 24 hours. The emergency action levels are:

UNUSUAL EVENTS - **20,000 AEC*** averaged over 24 hours
ALERT EVENTS - **100,000 AEC** averaged over 24 hours
SITE AREA EMERGENCY - **500,000 AEC** averaged over 24 hours

These overlays are to graphically assist the operator's judgement as to the extent of release.

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

HIGH STACK MONITOR INDICATIONS (Cont'd)

A. IODINE and PARTICULATE:]

Check the stack monitor reading **using appropriate overlay**. The ranges] of values represented on the overlay are the threshold levels of concentrations corresponding to specific emergency events in excess of Technical Specification limits.

NOTE: For particulate release, if the nuclide cannot be identified] **the AEC is 1E-12 μCi/ml. This makes timely identification of**] **the particulate(s) of interest extremely important (e.g., if**] **particulate were identified as Rubidium-88 the AEC is**] **9E-8 μCi/ml, a concentration 90,000 times greater than for**] **an unknown particulate).**]

B. GAS (**use gas overlay**)]

1. IF gas concentration exceeds **8.3 x 10^3** CPM (**20,000 AEC***) but less] than **4.2 x 10^4** CPM (**100,000 AEC**), and remains between these levels] for 1 hour with no evidence of declining, the event shall be classified as an UNUSUAL EVENT.

2. IF gas concentration exceeds **4.2 x 10^4** (**100,000 AEC**) but less than] **2.1 x 10^5** CPM (**500,000 AEC**) and remains between these levels for] 1 hour with no evidence of declining, the event shall be classified as an ALERT.

3. IF gas concentration exceeds 2.1 **x 10^5** CPM (**500,000 AEC**) and] remains **above this level** for 1 hour with no evidence of declining, the] event shall be classified as a SITE AREA EMERGENCY.

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

REACTOR STARTUP CHECKSHEET
FULL POWER OPERATION
BUILDING AND MECHANICAL EQUIPMENT CHECKLIST

Date: _____
Time (Started): _____

- [ ] 1. Emergency air compressor (load test for 30 minutes after maintenance day).
- [ ] 2. Beamport Floor:
  - [ ] a. Beamport radiation shielding (as required).
  - [ ] b. Beamport status checked/updated.
  - [ ] c. Seal trench low level alarm tested (after maintenance day).
  - [ ] d. Check closed beamport floor access gates.
- [ ] 3. a. Check operation of fan failure buzzer and warning light. Notify Alpha Lab of momentary ventilation loss. (Req'd if shutdown longer than 4 hours.)
  - [ ] b. Test stack monitor and low flow alarm per SOP while in west tower.
  - [ ] c. Test UPS alarm panel.
- [ ] 4. Emergency generat[or] availability checked as per Sect. I.A. and III. of D.G. checklist. (If shutdown for gre[ater] than 24 hours, run emergency generator for 30 minutes.)
- [ ] 5. Emergency pool fi[ll] (Check valves PIV-1 and PIV-2 locked open.)
- [ ] 6. Visual check of CT and secondary equipment:
  - [ ] a. Oil level in CT fans normal (after maintenance day).
  - [ ] b. Secondary makeup isolation valve power switch closed, valve cycled to verify operation and placed in auto mode.
- [ ] 7. Visual check of room 114 equipment:
  - [ ] a. Valve Op Air compressor oil level normal and cutout switch in auto.
  - [ ] b. Main air back-up valve VOP 33 open.
  - [ ] c. Air valve for valve operating header (VOP 31) open.
  - [ ] d. P501A and P501B coolant water valves open.
  - [ ] e. Check valves 599A and 599B open.
  - [ ] f. Pump controllers unlocked to start (as required).
  - [ ] g. S1 hydraulic pump on (oil level normal).
  - [ ] h. Valve S1 cycled in manual mode and positioned as required.
  - [ ] i. Vent the pool hold-up tank.
  - [ ] j. Vent the pool skimmer system pump.
  - [ ] k. Check the pipe trench free of water. Check the four pipe annulus drain valves for water leakage after maintenance days.
  - [ ] l. Add DI water to beamport and pool overflow loop seals.
  - [ ] m. Check oil reservoir for pumps 501A, 501B, and 533 for adequate supply. Add if necessary.
  - [ ] n. Visually check room 114 and DI area after all systems are in operation.
- [ ] 8. Reactor Pool:
  - [ ] a. Reflector experimental loadings verified and secured for start-up.
  - [ ] b. Flux trap experimental loading verified and secured for start-up, or strainer in place.
  - [ ] c. Check power on and reset, as necessary, silicon integrator, totalizer setting, silicon rotator, and alarm system.

☐ d. ARMS trip setpoints checked and tripped, check buzzer operational locally for all channels and remotely for channels 6 and 7.

Channel 4 - Exhaust Plenum
Channel 6 - Bridge ALARA
Channel 7 - Reactor Bridge
Channel 11 - Exhaust Plenum #2 (B/U)

☐ e. Reactor isolation horns switch in "Isolation Horns On" position. Valves and doors open.
☐ f. All ARMS trips set per SOP.
☐ g. Check ventilation fans, containment and backup doors.
☐ h. Announce completion of test to facility evacuation isolation system.]
(Reset security cabinet alarm at keypad and notify police.)]

☐ 20. Operate reg blade from full-out to full-in and set at 10" + .05".
☐ a. Check rod run-in function at 10% withdrawn and annunciator at rod bottomed.
☐ 21. Raise blade A to 2" and manually scram.
☐ 22. Raise blade B to 2" and trip manual rod run-in.
☐ 23. Raise blade C to 2" and scram by WRM trip.
☐ 24. Raise blade D to 2" and scram by IRM trip.
☐ 25. Annunciator board energized; horn on.
☐ 26. Jumper and tag log cleared or updated.
☐ 27. IRM recorder in fast speed.
☐ 28. Check magnet current for 90 ma on each magnet.
☐ 29. Cycle WRM range switch.
☐ 30. Reset "white rat" scram monitor.
☐ 31. Estimated critical blade position (corrected): _____ inches.
☐ 32. Pre-startup process data taken.
☐ 33. Routine patrol completed.
☐ 34. All reactor and license related systems upon which maintenance was performed have been reviewed and are operable.
☐ 35. Reactor ready for startup.

Time (Completed): _____
Shift Supervisor/Lead Senior Operator

RETURN ORIGINAL TO HEALTH PHYSICS OFFICE

No. _____

WASTE TANK SAMPLE REPORT

TANK NO. _____ TANK LEVEL _____ (Liters)

SAMPLER _____ TIME _____ DATE _____

1. Analysis Results

	Nuclide	Half Life	Physical Form	Concentration	WEC*	Activity
a.	H-3	12.3Y				
b.						

FRACTION OF WEC _____

pH _____

(Note: pH must be between 5.5 - 9.5 for release)

Analysis by _____ TIME _____ DATE _____

	Concentration (μ Ci/ml)	Total Volume (liters)	Activity (mCi)
(a)			
(b)			

2. Approvals Required for:

Any Discharge ..... _____ Shift Supervisor

Discharge of > 10 mci of H-3, > 2 mci of other activity, or to Secondary System _____ Reactor Manager

Discharge Limit Approved ..... _____ Health Physics

3. Action Taken

Date Discharged _____ Time Discharged _____ Volume Discharged _____ (Liters)

Tank Discharged to (check one): ☐ Sanitary Sewer ☐ Secondary System ☐ Not Discharged

REMARKS _____

*Water Effluent Concentration, 10CFR20, Appendix B, Table 2, Column 2.

Rev. 1/6/94 App'd _____ SOP/A-11a

MURR OPERATOR ACTIVE STATUS LOG (cont'd)

OPERATOR NAME: _____

YEAR: _____

NOTE: This form is for documenting active status of licensed operators assigned to rotating shifts.

QUARTER 1

☐ Active status needs to be documented to meet minimum requirements (4 hours)

☐ Active status lapsed, documentation required for return to active status (6 hours)

_____
Shift Supervisor Initial

Date	Total Time	Activity	Shift Supervisor Initial (for SROs) SRO Initial (for ROs)

QUARTER 2

☐ Active status needs to be documented to meet minimum requirements (4 hours)

☐ Active status lapsed, documentation required for return to active status (6 hours)

_____
Shift Supervisor Initial

Date	Total Time	Activity	Shift Supervisor Initial (for SROs) SRO Initial (for ROs)

MURR OPERATOR ACTIVE STATUS LOG (cont'd)

OPERATOR NAME: _____

YEAR: _____

NOTE: This form is for documenting active status of licensed operators assigned to rotating shifts.

QUARTER 3

☐ Active status needs to be documented to meet minimum requirements (4 hours)

☐ Active status lapsed, documentation required for return to active status (6 hours)

Shift Supervisor Initial

Date	Total Time	Activity	Shift Supervisor Initial (for SROs) SRO Initial (for ROs)

QUARTER 4

☐ Active status needs to be documented to meet minimum requirements (4 hours)

☐ Active status lapsed, documentation required for return to active status (6 hours)

Shift Supervisor Initial

Date	Total Time	Activity	Shift Supervisor Initial (for SROs) SRO Initial (for ROs)

STANDARD OPERATING PROCEDURES

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

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

Revision Number 13

Revision Date: 10/20/94

Page Number	Page Number
SOP/VIII-21	SOP/A-8a
SOP/VIII-22	SOP/A-8b
SOP/VIII-23	SOP/A-11a
SOP/VIII-24	
SOP/VIII-25	
SOP/VIII-26	
SOP/VIII-27	
SOP/VIII-34	
SOP/VIII-35	

VIII.4.2 Beamport "A" Procedures

CAUTION: The reactor shall be shutdown before any drain or fill operation is performed.

NOTE: All valve manipulations shall be made by Reactor Operations personnel. A health physicist shall be present for any draining or filling evolution.

A. Flooding/Filling Beamport "A" with DI Water
   1. Check the beamport DI supply valve open (above the sample station at room 114 entrance).
   2. Check closed BP-1, BP-11, BP-B13, BP-C13, BP-A16, BP-5, BP-3, BP-4, and BP-2.
   3. Open BP-A17 (beamport "A" vent).
   4. Slowly open BP-8 to bleed helium pressure off.
   5. Close BP-8 and BP-A17.
   6. Open BP-A14 and BP-A15 (surge tank isolations).
   7. Open BP-A13 (located in trench).
   8. Slowly open BP-2 (should feel and hear water flow).
   9. When surge tank is half full shut BP-2.
   10. Shut BP-A13.
   11. Log in console log beamport "A" flooded, and update Fuel Inventory Sheet.

B. Flooding/Filling Beamport "A" with Super Water
   1. Check closed BP-1, BP-2, BP-11, BP-B13, BP-C13, BP-A16, BP-5, BP-3, and BP-4.
   2. Open BP-A17 (beamport "A" vent).
   3. Slowly open BP-8 to bleed helium pressure off.
   4. Close BP-8 and BP-A17.
   5. Open BP-A14 and BP-A15 (surge tank isolations).
   6. Open BP-A13 (located in trench).
   7. Open BP-1 and start adding super water to funnel located on mezzanine (takes ≈ 10 gallons of water).
   8. When surge tank is half full, shut BP-1.
   9. Shut BP-A13.
   10. Log in console log beamport "A" flooded with super water, and update Fuel Inventory Sheet.

C. Adding DI Water to Beamport "A"

CAUTION: Use this procedure only when water level is visible in the surge tank or plastic hose connecting to the surge tank.

NOTE: Inform shift supervisor that the surge tank is low and request permission to refill the surge tank.

1. Check closed BP-5, BP-1, BP-3, BP-4, BP-11, BP-B13, BP-C13, and BP-2.
2. Open BP-A13 (located in seal trench).
3. Slowly open BP-2.
4. When surge tank is half full, shut BP-2 and BP-A13.

D. Draining Beamport "A"

CAUTION: All drained water is highly tritiated and should, whenever possible, be collected in containers rather than be allowed to drain to pipe trench. The only time BP-5 should be open is to drain the leg between BP-3, BP-4, and BP-5.

1. Connect helium bottle with regulator to the line on biological shield manifold.
2. Set regulator to 5 psig.
3. Place tygon hose from BP-4 into 5 gallon poly jug.
   NOTE: Have H.P. present before beginning to drain.
4. Check closed BP-A13, BP-B13, BP-C13, BP-5, BP-1, BP-2, BP-7, BP-10, BP-11, BP-9, BP-8, BP-12, BP-A16, and BP-A17.
5. Check open BP-A14 and BP-A15.
6. Open BP-A13 and BP-4.
7. When surge tank is empty, shut BP-A14 and BP-A15 (surge tank isolations).
8. Open BP-A16 (beamport "A" helium fill).
9. Slowly open BP-7 to get steady drain rate into the poly jug through BP-4.
10. When completely drained, flow helium through beamport for 30 minutes to dry out beamport.
11. Shut BP-A13 and BP-4.
12. Shut BP-A16 and BP-7.
13. Disconnect helium bottle from manifold and log in console log that beamport "A" has been backfilled with helium, and update Fuel Inventory Sheet. Dispose of the tritiated water as directed by Health Physics.

VIII.4.3 Beamport "B" Procedures

CAUTION: The reactor shall be shutdown before any drain or fill operation is performed.

NOTE: All valve manipulations shall be made by Reactor Operations personnel. A health physicist shall be present for any draining or filling evolution.

A. Flooding/Filling Beamport "B" with DI Water
   1. Check the beamport DI supply valve open (above the sample station at room 114 entrance).
   2. Check closed BP-1, BP-11, BP-A13, BP-C13, BP-B16, BP-5, BP-3, BP-4, and BP-2.
   3. Open BP-B17 (beamport "B" vent).
   4. Slowly open BP-8 to bleed helium pressure off.
   5. Close BP-8 and BP-B17.
   6. Open BP-B14 and BP-B15 (surge tank isolations).
   7. Open BP-B13 (located in trench).
   8. Slowly open BP-2 (should feel and hear water flow).
   9. When surge tank is half full shut BP-2.
   10. Shut BP-B13.
   11. Log in console log beamport "B" flooded, and update Fuel Inventory Sheet.

B. Flooding/Filling Beamport "B" with Super Water
   1. Check closed BP-1, BP-2, BP-11, BP-A13, BP-C13, BP-B16, BP-5, BP-3, and BP-4.
   2. Open BP-B17 (beamport "B" vent).
   3. Slowly open BP-8 to bleed helium pressure off.
   4. Close BP-8 and BP-B17.
   5. Open BP-B14 and BP-B15 (surge tank isolations).
   6. Open BP-B13 (located in trench).
   7. Open BP-1 and start adding super water to funnel located on mezzanine (takes ≈ 10 gallons of water).
   8. When surge tank is half full, shut BP-1.
   9. Shut BP-B13.
   10. Log in console log beamport "B" flooded with super water, and update Fuel Inventory Sheet.

Rev. 10/20/94 App'd [signature]
Section VIII.4.3 renumbered and revised in its entirety.

C. Adding DI Water to Beamport "B"

CAUTION: Use this procedure only when water level is visible in the surge tank or plastic hose connecting to the surge tank.

NOTE: Inform shift supervisor that the surge tank is low and request permission to refill the surge tank.

1. Check closed BP-5, BP-1, BP-3, BP-4, BP-11, BP-A13, BP-C13, and BP-2.
2. Open BP-B13 (located in seal trench).
3. Slowly open BP-2.
4. When surge tank is half full, shut BP-2 and BP-B13.

D. Draining Beamport "B"

CAUTION: All drained water is highly tritiated and should, whenever possible, be collected in containers rather than be allowed to drain to pipe trench. The only time BP-5 should be open is to drain the leg between BP-3, BP-4, and BP-5.

1. Connect helium bottle with regulator to the line on biological shield manifold.
2. Set regulator to 5 psig.
3. Place tygon hose from BP-4 into 5 gallon poly jug.
   NOTE: Have H.P. present before beginning to drain.
4. Check closed BP-A13, BP-B13, BP-C13, BP-5, BP-1, BP-2, BP-7, BP-10, BP-11, BP-9, BP-8, BP-12, BP-B16, and BP-B17.
5. Check open BP-B14 and BP-B15.
6. Open BP-B13 and BP-4.
7. When surge tank is empty, shut BP-B14 and BP-B15 (surge tank isolations).
8. Open BP-B16 (beamport "B" helium fill).
9. Slowly open BP-7 to get steady drain rate into the poly jug through BP-4.
10. When completely drained, flow helium through beamport for 30 minutes to dry out beamport.
11. Shut BP-B13 and BP-4.
12. Shut BP-B16 and BP-7.
13. Disconnect helium bottle from manifold and log in console log that beamport "B" has been backfilled with helium, and update Fuel Inventory Sheet. Dispose of the tritiated water as directed by Health Physics.

Section VIII.4.3 renumbered and revised in its entirety.

VIII.4.4 Beamport "C" Procedures

CAUTION: The reactor shall be shutdown before any drain or fill operation is performed.

NOTE: All valve manipulations shall be made by Reactor Operations personnel. A health physicist shall be present for any draining or filling evolution.

A. Flooding/Filling Beamport "C" with DI Water
   1. Check the beamport DI supply valve open (above the sample station at room 114 entrance).
   2. Check closed BP-1, BP-11, BP-A13, BP-B13, BP-C16, BP-5, BP-3, BP-4, and BP-2.
   3. Open BP-C17 (beamport "C" vent).
   4. Slowly open BP-8 to bleed helium pressure off.
   5. Close BP-8 and BP-C17.
   6. Open BP-C14 and BP-C15 (surge tank isolations).
   7. Open BP-C13 (located in trench).
   8. Slowly open BP-2 (should feel and hear water flow).
   9. When surge tank is half full, shut BP-2.
   10. Shut BP-C13.
   11. Log in console log beamport "C" flooded.

B. Flooding/Filling the Beamport with Super Water
   1. Check closed BP-1, BP-2, BP-11, BP-A13, BP-B13, BP-C16, BP-5, BP-3, and BP-4.
   2. Open BP-C17 (beamport "C" vent).
   3. Slowly open BP-8 to bleed helium pressure off.
   4. Close BP-8 and BP-C17.
   5. Open BP-C14 and BP-C15 (surge tank isolations).
   6. Open BP-C13 (located in trench).
   7. Open BP-1 and start adding super water to funnel located on mezzanine (takes ≈ 10 gallons of water)
   8. When surge tank is half full, shut BP-1.
   9. Shut BP-C13.
   10. Log in console log beamport "C" flooded with super water, and update Fuel Inventory Sheet.

Section VIII.4.4 renumbered and revised in its entirety.

C. Adding DI Water to Beamport "C"

CAUTION: Use this procedure only when water level is visible in the surge tank or plastic hose connecting to the surge tank.

NOTE: Inform shift supervisor that the surge tank is low and request permission to refill the surge tank.

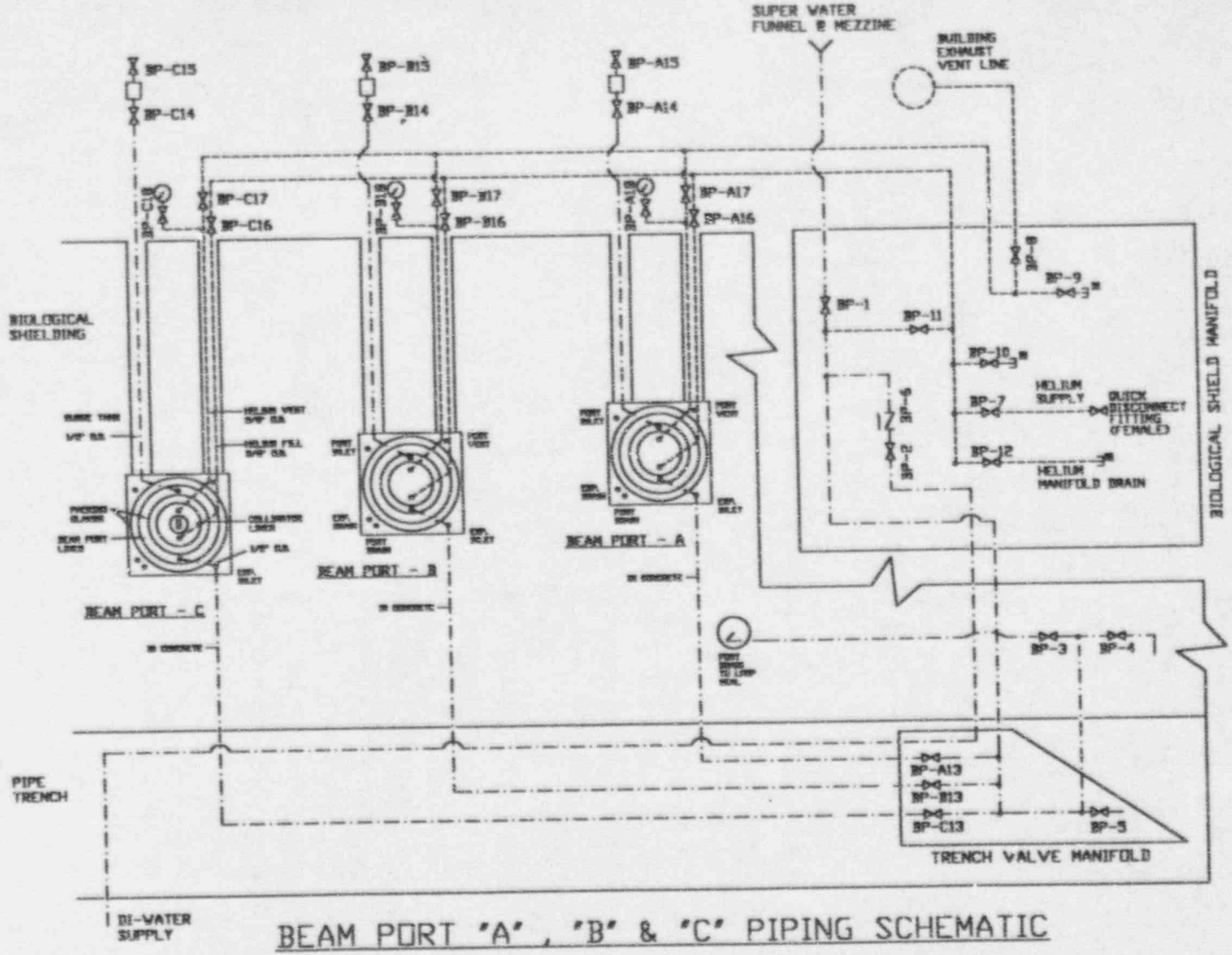
1. Check closed BP-5, BP-1, BP-3, BP-4, BP-11, BP-A13, BP-B13, and BP-2.
2. Open BP-C13 (located in seal trench).
3. Slowly open BP-2.
4. When surge tank is half full, shut BP-2 and BP-C13.

D. Draining Beamport "C"

CAUTION: All drained water is highly tritiated and should, whenever possible, be collected in containers rather than be allowed to drain to pipe trench. The only time BP-5 should be open is to drain the leg between BP-3, BP-4, and BP-5.

1. Connect helium bottle with regulator to the line on biological shield manifold.
2. Set regulator to 5 psig.
3. Place tygon hose from BP-4 into 5 gallon poly jug.
   NOTE: Have H.P. present before beginning to drain.
4. Check closed BP-A13, BP-B13, BP-C13, BP-5, BP-1, BP-2, BP-7, BP-10, BP-11, BP-9, BP-8, BP-12, BP-C16, and BP-C17.
5. Check open BP-C14 and BP-C15.
6. Open BP-C13 and BP-4.
7. When surge tank is empty, shut BP-C14 and BP-C15 (surge tank isolations).
8. Open BP-C16 (beamport "C" helium fill).
9. Slowly open BP-7 to get steady drain rate into the poly jug through BP-4.
10. When completely drained, flow helium through beamport for 30 minutes to dry out beamport.
11. Shut BP-C13 and BP-4.
12. Shut BP-C16 and BP-7.
13. Disconnect helium bottle from manifold and log in console log that beamport "C" has been backfilled with helium. Dispose of the tritiated water as directed by Health Physics.

New 10/20/94 App'd



BEAM PORT "A", "B" & "C" PIPING SCHEMATIC

N.T.S.

LEGEND

BP-1	BP LINER SUPER WATER SYPPLY
BP-2	BP LINER DI-WATER SUPPLY
BP-3	LOOP SEAL DRAIN
BP-4	TRENCH DRAIN
BP-5	TRENCH MANIFOLD DRAIN
BP-6	DI-WATER SUPPLY CHECK VALVE
BP-7	HELIUM SUPPLY
BP-8	HELIUM EXHAUST
BP-9	MOLECULAR SEIVE INLET
BP-10	MOLECULAR SEIVE OUTLET
BP-11	HELIUM PURGE OF TRENCH DRAIN
BP-12	HELIUM MANIFOLD DRAIN
BP-13	BP LINER DRAIN/FILL
BP-14	SURGE TANK INLET
BP-15	SURGE TANK VENT
BP-16	HELIUM FILL
BP-17	HELIUM VENT
BP-18	HELIUM PRESSURE GAUGE

NOTE:
VALVE NUMBERS BP-13 THRU BP-18 REPRESENT 3 INDEPENDENT VALVES (ONE FOR EACH BEAM PORT)
EXAMPLE: BP-A13, BP-B13, BP-C13

REVISION (2) -UPDATED -6/21/94-JDR

DATE: 12/3/93
DRAWN BY: E.E.E.
CHECKED BY:
DESIGNED BY:
E.E.E.
QUAD:
REVISION NUMBER: # 2
REVISION DATE: 6/21/94

UNIVERSITY OF MISSOURI-COLUMBIA
FACILITIES OPERATIONS
research reactor facility

BEAM PORT A,B, & C
PIPING SCHEMATIC

MURR NUMBER: 2355

SHEET 1 of 1

VIII.4.7 Operating Procedures for Beamport "F"]

The following procedures shall be used for operation of Beamport "F". All valve and tube changes shall be made by Reactor Operations personnel. Major shielding movements and all center tube adjustments or changes shall be coordinated with Health Physics and Reactor Operations personnel. A copy of this procedure shall be posted near Beamport "F" and a copy shall be put in the Beamport "F" log book.

CAUTIONS:

- **Ensure** center tube is not left fully inserted; allow at least 1/4 inch for] thermal expansion.
- After the center tube is inserted, verify drain and vent valves are shut.
- To prevent a partially filled beam tube leaving a crack for radiation, be sure the vent tank has water in it.
- To limit handling of a very radioactive filter tube, pull the tube back four feet and let it decay for > 2 days before withdrawing it. Have Health Physics coverage.
- To limit tritium release, limit leakage of water.
- To prevent excessive personnel exposure, make sure filter parts are in tube and pushed forward to reactor end of filter tube. Apply vacuum slowly so that filter parts are not sucked back. Have Health Physics coverage on startup.
- After startup, check radiation survey readings against previous readings with similar filters.
- Make it a habit to stay out of beams, whether they are open or "closed."

NOTE: The experimental can may be flooded or drained only when the reactor is shutdown.

The water level in the surge tank shall be checked and maintained by Operations. Makeup water should be "super" water.

The **principal** experimenter should send a not to Operations asking for a] change in filters and tubes. The note should reach Operations before the shutdown. The **principal** experimenter is responsible for verifying the] desired filtering material is in a center tube before it is inserted and that it is covered in his RUR. To facilitate in verifying materials, all filter parts should be marked and their storage should be controlled because of their activation and potential contamination.

A. Installing Center Tubes in Beamport "F"

1. Center tubes shall be installed into Beamport "F" only with the reactor shutdown.
2. Verify the Beamport "F" center tube sealing "O"-ring is in place and in good condition.
3. With Health Physics coverage, transfer the desired center tube from storage to Beamport "F" and insert it until contact is made with the ball valve. Note the change in the Beamport Storage Log.
4. Lightly tighten the center tube "O"-ring packing nut; check the drain valve and vent valve closed and open the surge tank line valve.
5. Open the center tube ball valve and insert the center tube. The center tube packing nut may need to be adjusted so the tube can be inserted with minimal water leakage.
6. With the center tube fully inserted, pull the tube out the distance desired by the experimenter. It must be pulled out at least 1/4 inch to allow for thermal expansion.]
7. The center tube end plate shall be removed and a rod inserted in the tube to verify the filter slugs are at the end of the tube closest to the reactor core.
8. The vacuum pump shall be hooked up and started before the reactor is taken critical. The vacuum should be applied slowly so that suction will not pull back the filter parts.
9. A beamport radiation survey shall be completed after the reactor is started up at 10 MW.

B. Adjustments to Beamport "F" Center Tube

The center tube shall only be adjusted with the reactor subcritical. Adjustments including changing the distance the center tube is from the core and pulling or adding parts from the center tube.

1. Take the reactor subcritical before adjusting the center tube.
2. If the center tube is moved, **ensure** it is not closer than 1/4 inch] from being fully inserted.
3. After adjustments are made and vacuum restored, return reactor to normal operations, and perform a Beamport "F" radiation survey.

DATE: _____

REACTOR ROUTINE PATROL

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 ± 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, gage ≥ 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°F						
18. Argon bank pressure	> 200 psig						
19. Full N2 bottles	Total > 3						
20. Bank on service	A or B						]
21. Bank A bottle pressure	> 250 psig						]
22. Bank B bottle pressure	>250 psig						]
23. N2 header pressure	135-145 psi						]
24. T-300 level	> 2100 gal						]
25. T-301 level	< 6000 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: _____

26. Labyrinth sump	Level < Alarm Pt.							]
27. RO Unit	Condition normal							]
28. UPS room	No alarms indicated Temp. 60°-80°F							]
29. T-300, T-301 Room	Thermostat >55°F Temp. > 40 °F							]
30. Rm 114 particulate filter ΔP	< 3.5" water							]
31. EG. Rm (Perform complete checklist on Sunday)	Thermostat > 60°F Temp. > 50 °F							]
32. Battery charging current	< 1 amp							]
33. 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 dry 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							

RETURN ORIGINAL TO HEALTH PHYSICS OFFICE

No. _____

WASTE TANK SAMPLE REPORT

TANK NO. _____

TANK LEVEL _____ (Liters)

SAMPLER _____

TIME _____ DATE _____

1. Analysis Results

	Nuclide	Half Life	Physical Form	Concentration	RTS*	Activity
a.	H-3	12.3Y	_____	_____	_____	_____
b.	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____

FRACTION OF RTS _____

pH _____

(Note: pH must be between 5.5 - 9.5 for release)

Analysis by _____

TIME _____ DATE _____

	Concentration (μ Ci/ml)	Total Volume (liters)	Activity (mCi)
(a)	_____	_____	_____
(b)	_____	_____	_____

2. Approvals Required for:

Any Discharge ..... _____
Shift Supervisor

Discharge of > 10 mci of H-3, > 2 mci of other activity, or to Secondary System _____
Reactor Manager

Discharge Limit Approved ..... _____
Health Physics

3. Action Taken

Date Discharged _____ Time Discharged _____ Volume Discharged _____ (Liters)

Tank Discharged to (check one): ☐ Sanitary Sewer ☐ Secondary System ☐ Not Discharged

REMARKS _____

*Releases to Sewer, 10CFR20, Appendix B, Table 3.

MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

Revision Number 15

Revision Date: 4/4/94

SEP-8

EMERGENCY EQUIPMENT MAINTENANCE PROCEDURE

Purpose:
This procedure states how the operational readiness of emergency equipment and supplies required by the Emergency Procedures is to be maintained, calibrated, tested, and periodically inventoried.

Health Physics' Emergency Equipment:
Health Physics' Emergency Equipment and supplies required by the Site Emergency Procedures shall be maintained in two designated readily accessible locations. The two locations are the MURR Emergency Equipment Cabinets in the copy machine room and the Backup Emergency Equipment Cabinet at RPDB in room 10. The inventory checklists for each location are attached to this procedure and shall be used to verify quarterly that the contents of the cabinet meet at least the required levels. All maintenance and inventory records on emergency equipment shall be maintained in the Health Physics Office.

The civil defense kits stored at each location contain a G-M survey meter, an ion chamber meter (500 R/hr range), and a set of self-reading pocket dosimeters. These kits are exchanged routinely by Missouri SEMA for updated kits of instruments which have been calibrated by SEMA. The emergency Health Physics' equipment is supplemented by the Health Physics' instruments and equipment used for daily routine evaluations and is maintained and calibrated by the Operational Health Physics' Program.

Off-Gas Monitoring Equipment:
The off-gas stack monitor has three channels: gas, particulate, and iodine. The three channels shall be calibrated semiannually by the Health Physics/Reactor Chemistry group using Reactor Chemistry Standard Operating Procedures:

RC/III-2 Calibration of Stack Particulate Monitor
RC/III-3 Calibration of Stack Iodine Monitor
RC/III-4 Calibration of Stack Gas Monitor

The operability of the off-gas monitor is checked as part of the start-up checklist for normal reactor start-ups.

Fire Fighting Equipment:
The fire hydrant in the reactor site is checked operable routinely by the Columbia Fire Department. The fire extinguishers shall be checked annually by the University of Missouri Physical Plant.

Rev. 4/4/94 App'd WPM

EMERGENCY LOCKER INVENTORY
MURR COPY ROOM

Date _____

By _____

Number Required		Number Desired	
1	( )	2	flashlights - new batteries installed every 6 months. Date batteries when installing in flashlights.
1	( )	1	first aid kit
5	( )	5	"D" cell batteries replaced with new batteries every 6 months. Date batteries when placing in locker.
3	( )	5 boxes	swipes
0	( )	1 box	paper towels
0	( )	1 box	absorbent paper
2	( )	4 bars	face soap
3	( )	6	"Radioactive Material" tags
0	( )	2 rolls	tape
0	( )	1 roll	"Radioactive Material" tape
2	( )	2	full face respirators
2	( )	5	half face respirators
8	( )	10	spare filters for respirators
0	( )		assorted plastic bags
2	( )	4	NuCon permasigns
0	( )		NuCon permasign insets
1	( )	1 box	rubber gloves
4	( )	7 sets	protective clothing
0	( )	20 ft.	yellow and magenta rope
1	( )	1	Civil Defense instrument kit - date kit placed in cabinet _____

REMARKS: _____

_____

_____

_____

EMERGENCY LOCKER INVENTORY
RESEARCH PARK DEVELOPMENT BUILDING
(RPDB)

Date _____

By _____

Number Required		Number Desired	
1	( )	2	flashlights - new batteries installed every 6 months. Date batteries when installing in flashlights.
1	( )	1	first aid kit
5	( )	5	"D" cell batteries replaced with new batteries every 6 months. Date batteries when placing in locker.
3	( )	5 boxes	swipes
0	( )	1 box	paper towels
0	( )	1 box	absorbent paper
2	( )	4 bars	face soap
3	( )	6	"Radioactive Material" tags
0	( )	2 rolls	tape
0	( )	1 roll	"Radioactive Material" tape
2	( )	2	full face respirators
2	( )	3	half face respirators
8	( )	10	spare filters for respirators
0	( )		assorted plastic bags
2	( )	4	NuCon permasigns
0	( )		NuCon permasign insets
1	( )	1 box	rubber gloves
2	( )	2 sets	protective clothing
0	( )	20 ft.	yellow and magenta rope
1	( )	1	Civil Defense instrument kit - date kit placed in cabinet _____

REMARKS: _____

_____

_____

_____

EMERGENCY PROCEDURES
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	**474-7882**]
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	387-4859
T. Warner	816-882-6740

Health Physics/Rx. Chemistry

	Phone No.
J. Ernst	445-5621
R. Stevens	442-2539
J. Schuh	449-0992
R. Ayers	445-0340
W. D. Pickett	474-0709
A. Shipp	442-4304

Facilities Operations

	Phone No.
C. Edwards	443-7529
D. Peeler	816-848-2471
K. Beamer	682-5499
R. Kitch	**875-2045**]
C. Kribbs	682-3980
T. Seeger	474-3891
J. Baskett	474-2046
M. Richardson	446-1014

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. Storvick	445-4038
R. Dinger	**449-0992**]

Emergency Support Organizations

	Phone No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital & Clinics	
Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emergency Center)	882-8091
UMC Health Physics (Office)	882-7221
Sue Langhorst (Home)	**442-3534**]
Jamieson Shotts (Home)	474-2194
David Spate (Home)	657-9450
MU News Bureau	882-6211
See Public Information Procedure for other phone numbers (SEP-7).	882-6214 or 882-6217
State Emergency Management Agency (SEMA)	314-751-2746
NRC Washington, DC	301-951-0550
NRC Region III	708-829-9500
American Nuclear Insurers	203-561-3433

Rev. 4/4/94 App'd

MURR SITE EMERGENCY PROCEDURES AND
FACILITY EMERGENCY PROCEDURES

Revision Number 16

Revision Date: 7/29/94

TABLE II
EMERGENCY SUPPORT ORGANIZATIONS

a. UMC HEALTH PHYSICS SERVICES

In the event of a radiological emergency, the UMC Health Physics Services may be contacted to assist in checking facility personnel for contamination. After hours the UMC Police may be contacted to open the Research Park Development Building (backup emergency control center). One of the persons listed below will man the backup control center.

CONTACT	Office	Home
Dr. Sue M. Langhorst	882-7221	**442-3534**
Jamieson Shotts	882-7221	474-2194
David Spate	882-7221	657-9450

b. UMC POLICE

The UMC Police may be called to restrict entry to the facility. 24 hours 882-7201

c. UNIVERSITY OF MISSOURI HOSPITAL & CLINICS (UMH&C)

Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emerg. **Center**)	882-8091

The UMH&C should be contacted in the event of personal injury. In the event of personal contamination or radiation exposure without injury, see **FEP-4,** MEDICAL EMERGENCY PROCEDURES.

d. MU NEWS BUREAU - See SEP-7, PUBLIC INFORMATION PROCEDURE

This office will initially deal with questions from off-site. Direct any questions from media to this office. They will release statements only by EMERGENCY DIRECTOR authorization.

e. COLUMBIA FIRE DEPARTMENT

The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability. 24 hours 9-911
Ensure Office of University Relations is also called.
(Note: **Research Reactor street address is 1513 South Providence Road).**

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 x 10^5 cpm. Reevaluate chart reading 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 [301-816-5100] 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.

TABLE III
EMERGENCY SUPPORT ORGANIZATIONS

a. UMC HEALTH PHYSICS SERVICES

In the event of an ALERT condition, the UMC Health Physics Services may be contacted to man the backup emergency control center. After hours, call the UMC Police to open **the Research Park Development Building**.

CONTACT	Office	Home
Dr. Sue M. Langhorst	882-7221	**442-3534**
Jamieson Shotts	882-7221	474-2194
David Spate	882-7221	657-9450

b. UMC POLICE

The UMC Police may be called to restrict entry to the facility. 24 hours 882-7201

c. UNIVERSITY OF MISSOURI HOSPITAL & CLINICS (UMH&C)

Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emerg. **Center**)	882-8091

The UMH&C should be contacted in the event of personal injury. In the event of personal contamination or radiation exposure without injury, see **FEP-4,** MEDICAL EMERGENCY PROCEDURES.

d. MU NEWS BUREAU - See SEP-7, PUBLIC INFORMATION PROCEDURE

This office will initially deal with questions from off-site. Direct any questions from media to this office. They will release statements only by EMERGENCY DIRECTOR authorization.

e. COLUMBIA FIRE DEPARTMENT

The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability. 24 hours 9-911
Ensure Office of University Relations is also called.
(Note: **Research Reactor street address is 1513 South Providence Road).**

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 **[301-816-5100]** 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.

TABLE IV
EMERGENCY SUPPORT ORGANIZATIONS

a. UMC HEALTH PHYSICS SERVICES

In the event of a SITE AREA EMERGENCY, the UMC Health Physics Services may be contacted to man the backup emergency control center. After hours, call the UMC Police to open **the Research Park Development Building.**]

CONTACT	Office	Home	]
Dr. Sue M. Langhorst	882-7221	**442-3534**	
Jamieson Shotts	882-7221	474-2194	
David Spate	882-7221	657-9450	

b. UMC POLICE

	24 hours
The UMC Police may be called to restrict entry to the facility.	882-7201

c. UNIVERSITY OF MISSOURI HOSPITAL & CLINICS (UMH&C)

Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emerg. **Center**)	882-8091]

The UMH&C should be contacted in the event of personal injury. In the event of personal contamination or radiation exposure without injury, see **FEP-4,**] MEDICAL EMERGENCY PROCEDURES.

d. MU NEWS BUREAU - See SEP-7, PUBLIC INFORMATION PROCEDURE

This office will initially deal with questions from off-site. Direct any questions from media to this office. They will release statements only by EMERGENCY DIRECTOR authorization.

e. COLUMBIA FIRE DEPARTMENT

	24 hours
The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability.	9-911
Ensure Office of University Relations is also called.	]
(Note: **Research Reactor street address is 1513 South Providence Road).**	]]

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 [301-216-5100] 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-5

PARTIAL SITE AREA EVACUATION PROCEDURE

(SEE ATTACHED SITE MAP)

1. When a PARTIAL SITE AREA EVACUATION is deemed necessary, the EMERGENCY DIRECTOR shall contact the UMC Police Department to have their personnel notify the affected laboratory and office spaces of the need to evacuate to the Research Park Development Building (RPDB).

   a. All personnel within the Golf Course Greenskeeper building, the Civil Engineering Freight Pipeline Research Laboratory building, the Laboratory Animal Center, and the Animal Psychology Laboratory in the Melvin H. Marx Research Laboratory building will proceed to the RPDB.

   b. All personnel within the Dalton Cardiovascular Research Center and USDA Biological Control of Insects Research Laboratory will proceed north to the RPDB.

   c. All personnel within the Blood Center will proceed north on Providence Road to the RPDB.

   d. All personnel who have evacuated the reactor building will proceed to the RPDB.

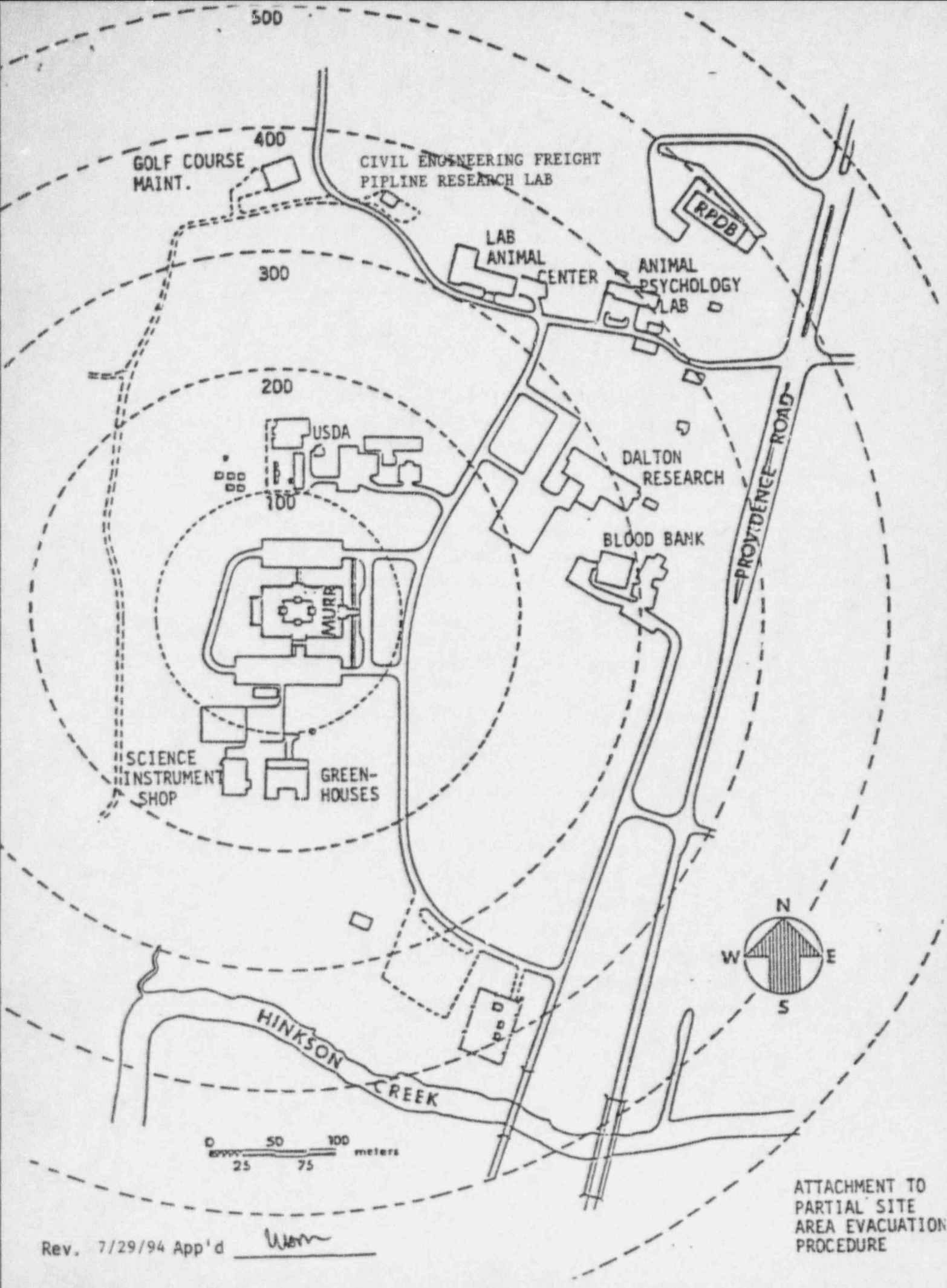
   e. All personnel in the Greenhouse and Science Instrument Shop will proceed to the RPDB.

Building	Number(s)
Golf Course Greenskeeper building	2-6226
Civil Engineering Freight Pipeline Research Lab building	2-3081
Laboratory Animal Center	2-4123 or 2-4122
Animal Psychology Laboratory	2-3811 or 2-4123
Dalton Cardiovascular Research Center	2-7586
USDA Biological Control of Insects Research Lab	875-5361
American Red Cross Blood Center	449-2656
Greenhouse	2-6276
Science Instrument Shop	2-3711 or 2-3712

Rev. 7/29/94 App'd Wagn

Revised in its entirety

]



ATTACHMENT TO PARTIAL SITE AREA EVACUATION PROCEDURE

Rev. 7/29/94 App'd _____

SEP-7

PUBLIC 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 882-9143 (Jill Scoggins)** or 882-9144 (Connie Mitchell) **or 882-6217 (Teresa Walker).**]

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)	Rhona Williams	449-1586
2)	**Jill Scoggins**	**874-9015**]
3)	Connie Mitchell	442-6166]
4)	**Teresa Walker**	**446-0006**]

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.

EMERGENCY PROCEDURES
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	474-7882
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	387-4859
T. Warner	816-882-6740

Health Physics/Rx. Chemistry

	Phone No.
J. Ernst	445-5621
R. Stevens	442-2539
J. Schuh	449-0992
R. Ayers	445-0340
W. D. Pickett	474-0709
A. Shipp	442-4304

Facilities Operations

	Phone. No.
C. Edwards	443-7529
D. Peeler	816-848-2471
K. Beamer	682-5499
R. Kitch	875-2045
C. Kribbs	682-3980
T. Seeger	474-3891
J. Baskett	474-2046
M. Richardson	446-1014

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. Storvick	445-4038
R. Dinger	449-0992

Emergency Support Organizations

	Phone. No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital & Clinics	
Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emergency Center)	882-8091
UMC Health Physics (Office)	882-7221
Sue Langhorst (Home)	442-3534
Jamieson Shotts (Home)	474-2194
David Spate (Home)	657-9450
MU News Bureau	882-6211
See Public Information Procedure for other phone numbers (SEP-7).	**882-9143]** **882-9144]**
State Emergency Management Agency (SEMA)	314-751-2748
NRC Washington, DC	**301-816-5100]**
NRC Region III	708-829-9500
American Nuclear Insurers	203-561-3433

Rev. 7/29/94 App'd

WORKSHEET C

CONTENTS OF INITIAL/FOLLOWUP EMERGENCY MESSAGES TO

"HEADQUARTERS OPERATIONS OFFICER"
WASHINGTON, D.C. 301-816-5100

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 _____

Rev. 7/29/94 App'd _____

D. Ensure all personnel are cleared from all levels of the containment building and exit via personnel airlock doors.

The DUTY OPERATOR shall report to the EMERGENCY COORDINATOR and advise him of the status of the reactor.

MANAGER OF HEALTH PHYSICS/REACTOR CHEMISTRY shall proceed to the lobby control center and establish the radiation-safe condition of the area.

Immediate actions may require the Manager of H.P./R.C. to:

1) establish a hot–cold change area;
2) assemble and prepare for use, special Health Physics equipment;
3) perform radiation and contamination surveys;
4) evaluate the extent of radioactive contamination and/or radiation exposure received by personnel at the time of the incident; and/or
5) advise the EMERGENCY DIRECTOR of measures to be taken to control radioactive contamination which may have resulted from the incident.

The EMERGENCY DIRECTOR shall appoint a COMMUNICATOR to notify auxiliary organizations which have been made aware of these emergency procedures and perform other communicative functions required. The following telephone numbers may be of assistance in the performance of these duties:

University Police/Watchman's Office, UMC	882-7201
Radiation Safety Office, UMC	882-7221
Emergency Room, UM Hospital & Clinics, UMC	882-8091

NOTE: When determined appropriate by the EMERGENCY DIRECTOR, the evacuation horns may be silenced by opening breaker 15 on the emergency lighting panel located in the north inner corridor next to the emergency power transfer switch.

FEP-3

FIRE PROCEDURE

IMMEDIATE ACTIONS:

1. Any individual discovering a fire shall notify the Reactor Control Room (#13 or 2-5213) of the fire.

If the fire cannot be extinguished with local fire extinguishers:

NOTE: This procedure is meant to serve as a guide to the EMERGENCY DIRECTOR. At his discretion any step may be altered or omitted as necessary.

2. The SHIFT SUPERVISOR will call 911 on the outside line (black phone) to notify the Columbia Fire Department. (**Note: Research Reactor street address is 1513 South Providence Road.**)
3. The SHIFT SUPERVISOR will initiate a Facility Evacuation.
4. The EMERGENCY DIRECTOR will investigate the source of the fire and determine the steps to minimize hazards until the Fire Department arrives.
5. Secure EF-13 and EF-14 if there is a potential for the fire spreading through the ventilation system.
6. Secure the ventilation supply fan SF-1, the north RTAH, the south RTAH, and close all fire doors.

NOTE: The assessment of off-site radiological consequences shall be determined. This assessment may require escalating emergency response to a Site Emergency Procedure (Unusual Event, Alert).

SUPPLEMENTAL ACTIONS:

1. The EMERGENCY DIRECTOR or EMERGENCY COORDINATOR should meet the Fire Department in the upwind parking lot.
2. The EMERGENCY DIRECTOR will maintain contact with the INCIDENT COMMANDER at the Command Post.
3. The EMERGENCY DIRECTOR should contact the MU News Bureau to handle public information.
4. The EMERGENCY DIRECTOR will assist the INCIDENT COMMANDER in coordinating fire fighting and lifesaving measures.
5. The EMERGENCY DIRECTOR will advise the INCIDENT COMMANDER of any proposed action that may violate the Facility NRC license.

FEP-4

MEDICAL EMERGENCY PROCEDURE

Injuries which may or may not involve radiation exposure and/or radioactivity contamination are classified as follows by the UMH&C **Emergency Action Plan - Radiation Response.**

1. External Radiation - The individual who **may have** received **a large external** dose of radiation **is of no risk** to attendants, other patients or the environment. **This individual** is no different than the x-ray patient.

2. Inhalation or Ingestion - Another type is the individual who **may have** received internal contamination by inhalation or ingestion. **This person** is no **significant** hazard to attendants, other patients or the environment. Following cleansing of **any** minor amount of contaminated material deposited on the body surface during airborne exposure, **exposure** is similar to the chemical poisoning case such as lead. Body wastes should be collected and saved for measurement of the amount of nuclides to assist in determination of appropriate therapy. **Persons attending those patients must wear gloves to avoid the possibility of contamination.**

3. External Contamination - External contamination of body surface and/or clothing by liquids or by dirt particles **containing radioactivity presents the possibility of a radiation risk to attendants and the environment.** Surgical isolation techniques **should be followed** to protect attendants **from radioactive contamination. Decontamination must be performed, or the contamination fixed, to avoid contamination of the area.**

4. External Contamination Complicated by a Wound - Care must be taken not to contaminate **the wound from** surrounding surfaces and vice versa. The wound and surrounding surfaces are cleansed separately and sealed off when clean. When crushed dirty tissue is involved, early preliminary wet debridement following wound irrigation may be indicated. Further debridement and more definitive therapy can await sophisticated measurement and consultation guidance.

Upon discovery that an accident has occurred, the following action is to be taken:

A. If the area in which the accident has occurred is a "high radiation area" with an exposure dose rate of 100 mR/hr or more, or is suspected to be such an area, move the victim quickly and carefully to a location at which the exposure dose rate is 5 mR/hr or less if the victim can be moved without harm. Evacuate all personnel from the accident area and provide first aid to the victim.

B. Notify the Reactor Operator in the Control Room (2-5213).

Accident Involving Physical Injury:

A. **Control Room Operator will** notify the Emergency Room, UMH&C at] 882-8091, and arrange for medical care either at the Facility or at UMH&C.

B. Control Room Operator will call Health Physics Manager at **(2-5226)** or by] page. If the Health Physics Manager or health physics representative cannot be reached, call UMC Health Physics at 882-7221.

Upon arrival at the accident scene, Health Physics **and/or Shift Supervisor** will] take the following action:

A. Assess the severity of the radiation injury and classify the injury.

B. If necessary, recommend to the Shift Supervisor to seal off the accident] area and secure ventilation to that area.

C. If initial treatment is to be administered at the Facility by a representative] of the UMH&C, attend the accident victim, keep him comfortable, and render first aid as required.

D. Survey all personnel who may have been contaminated in the accident.] Provide first aid as required.

E. Provide decontamination of the accident victim, if possible, and all other] persons found to be contaminated.

F. Save all samples of clothes, jewelry, etc. Label the samples with name,] time and date.

G. Notify the Facility Director and the Radiation Safety Officer.]

H. Evaluate the radiation dose received by carefully reconstructing the accident. This assessment is more detailed than that required in item A above and may be deferred until after the care of the accident victim is transferred to the attending physician.]

Contamination and/or Radiation Exposure Without Physical Injury:

Contamination

If immediate emergency cleaning of contaminated person's skin cannot reduce level to 1 mR/hr $\beta\gamma$ or 1000 dpm α, they should be sent to the Research Park Development Building for further health physics evaluation and/or decontamination.

Ensure that one of the following persons will be at the Research Park Development Building to assist in evaluating the need to move the person to the UMH&C. (Health Physics Manager or UMC Health Physicist)

Radiation

If a person has an estimated 10 REM exposure to any part of the body or whole body, send to Research Park Development Building for further medical/health physics evaluation.

Transportation Routes to the UMC Hospital and Clinics, **see Figure 1, FEP-4**]

A. **University Hospital and Clinics: Accepts all Class I, Class II and Class III trauma patients and provides necessary medical treatment and decontamination. Care will be provided in Emergency Center per routine disaster protocol.**]

B. **VA Hospital: Accepts all overload Class III and non-injured patients (walking wounded) from University Hospital and Clinics and provides first aid and decontamination.**]

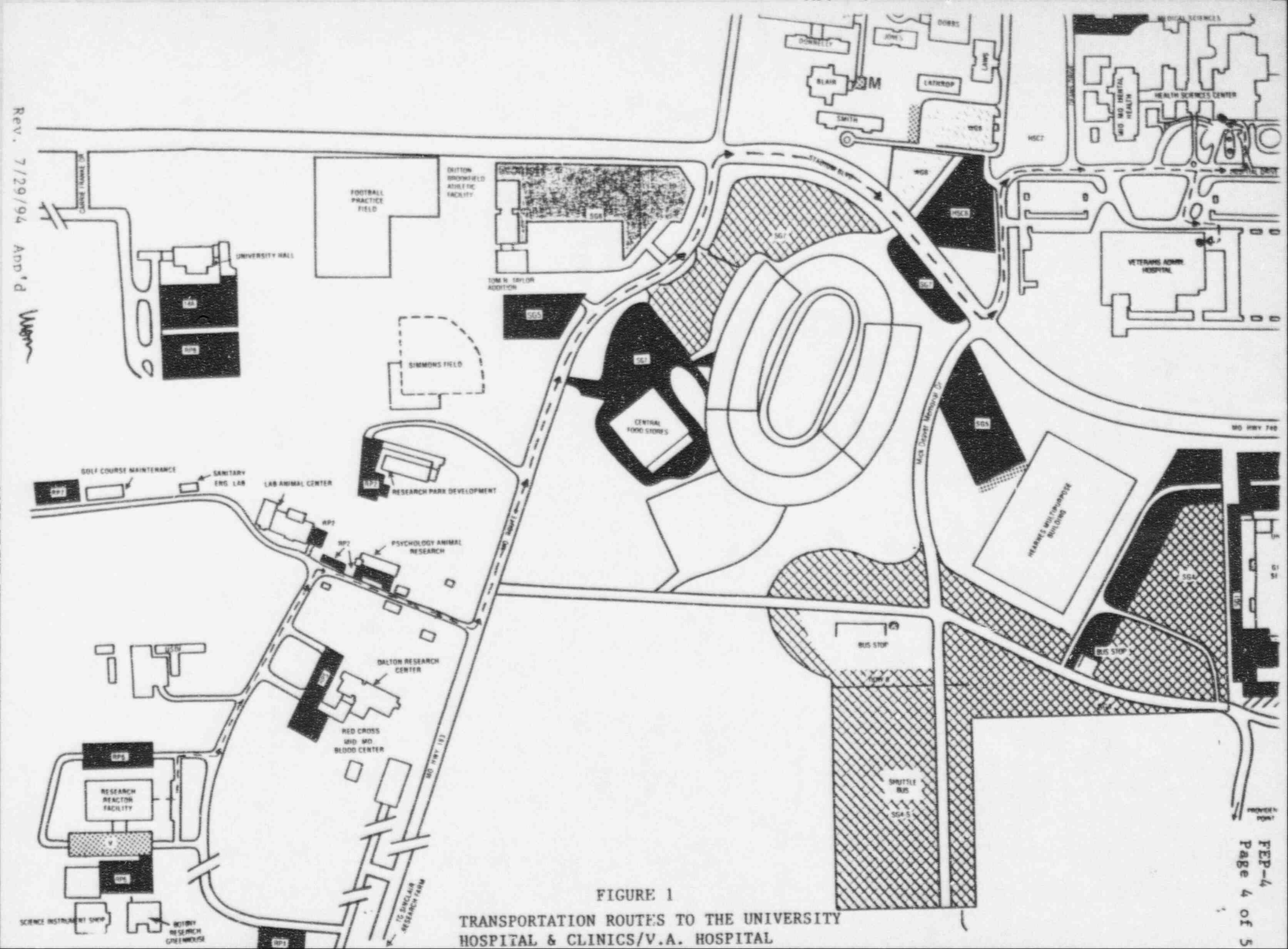


FIGURE 1

TRANSPORTATION ROUTES TO THE UNIVERSITY HOSPITAL & CLINICS/V.A. HOSPITAL

Rev. 7/29/94 App'd

RADIOLOGICAL CONTACTS

ASSISTANCE may be secured from the U.S. Department of Energy's REGIONAL COORDINATING OFFICES FOR RADIOLOGICAL EMERGENCY ASSISTANCE.

Telephone and personal contacts with trained physician, specialist, technicians, laboratories, health physicists, public relations and information officer specialists are available in the following areas:

Brookhaven Area Office
Upton, NY 11973
(516) 282-2200

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831
(615) 576-1005 or
(615) 525-7885

Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802
(803) 725-3333

Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87185-5400
(505) 845-4667

Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439
(708) 252-4800 duty hours
(708) 252-5731 off-duty hours

Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402
(208) 526-1515

San Francisco Operations Office
1301 Clay Street
Oakland, California 94612-5208
(510) 637-1794

Richland Operations Office
P.O. Box 550
Richland, Washington 99352
(509) 373-3800

References

1. U.S. Department of Energy. Emergency Handling of Radiation Accident Cases: Physicians (Prepared in cooperation with the American Medical Association) Washington, D.C. U.S. Government Printing Office, 1979.

2. Carol B. Jankowski, Radiation Emergency, American Journal of Nursing, Jan. 1982, pp. 90-97.

RADIATION RESPONSE

I. GENERAL INFORMATION

TYPES OF RADIATION ACCIDENTS

Poses no hazard to hospital personnel

External Radiation

The individual who may have received a large external dose of radiation is of no risk to attendants, other patients or the environment. This individual is no different than the X-ray patient.

Inhalation or Ingestion

Another type is the individual who may have received internal contamination by inhalation or ingestion. This person is no significant hazard to attendants, other patients or the environment. Following cleansing of any minor amount of contaminated material deposited on the body surface during airborne exposure, exposure is similar to the chemical poisoning case such as lead. Body wastes should be collected and saved for measurement of the amount of nuclides to assist in determination of appropriate therapy. Persons attending those patients must wear gloves to avoid the possibility of contaminates.

Potentially poses a hazard to hospital personnel

External Contamination

External contamination of body surface and/or clothing by liquids or by dirt particles containing radioactivity presents the possibility of a radiation risk to attendants and the environment. Surgical isolation techniques should be followed to protect attendants from radioactive contamination. Decontamination must be performed, or the contamination fixed, to avoid contamination of the area.

External Contamination Complicated by a Wound

Care must be taken not to contaminate the wound from surrounding surfaces and vice-versa. The wound and surrounding surfaces are

cleansed separately and sealed off when clean. When crushed dirty tissue is involved, early preliminary wet debridement following wound irrigation may be indicated. Further debridement and more definitive therapy can await sophisticated measurement and consultation guidance.

RADIATION PATIENT SEGREGATION

University Hospital and Clinics

Accepts all Class I, Class II and Class III trauma patients and provides necessary medical treatment and decontamination. Care will be provided in Emergency Center per routine disaster protocol.

VA Hospital

Accepts all overload Class III and non-injured patients (walking wounded) from University Hospital and Clinics and provides first aid and decontamination.

VAH Command Center will contact UHC Command Center if additional staffing or equipment is needed.

Patients are either discharged from VAH or directly admitted to UHC. Admissions should be arranged through VAH Command Center.

Transportation of patients from VAH to UHC will be made through the UHC Command Center.

II. FACILITY RESPONSE

ER CHARGE NURSE OR SUPERVISOR

1. Relay the information received about the reported disaster to the AOD, House Manager, ER Medical Director and on-duty Attending Physician, Emergency Services Manager, Emergency Center Assistant Manager.

2. Assess actual number of victims and severity of injuries.

AOD

1. Implement the Emergency Action Plan if situation warrants.

NOTE: Notify VA hospital if the amount of victims cannot be appropriately handled at the hospital. Only Class III patients and non-injured will be treated at the VA. During office hours, contact the VA Hospital Associate Director; after hours, contact the Medical Administrative Assistant.

2. Request from VA, if situation warrants, approval of transfer of Class III by EMS for treatment and decontamination by their facility. If approved by VA, notify ER at 2-8091 and inform them of VA approval to proceed.

TELECOMMUNICATIONS

1. Upon notification to initiate the Radiation Emergency Action Plan, announce "Radiation Emergency Action Plan is in effect" in the following manner:
   - Over the 0500 group pagers
   - By calling divisional representatives requested by the AOD

   By calling the following critical areas:

   - Radiology
   - Admissions
   - Health Physics
   - Distribution

SENIOR EMERGENCY CENTER RESPONSE PERSONNEL

1. Activate the Emergency Action Plan if directed to do so by the AOD.

2. Upon receipt of call announcing momentary arrival of radiation exposure victims supervise the following:

   a. Notify the Manager of Emergency Services

   b. Open Radiation Emergency Kits

   c. Establish treatment and decontamination at the Emergency Center.

   d. Don personal protective equipment and personal monitoring devices.

   e. Assist **Housekeeping** personnel in preparing the area for patient reception, setting up the control area to hold the anticipated number of victims.

   f. To prevent tracking of contaminates, instruct **House-keeping** to cover floor areas. Floor covering will be applied from ambulance entrance into treatment areas.

   g. Establish a control line at entrance of decontamination area and mark clearly with a wide strip of tape to differentiate the contaminated from uncontaminated side.

   h. Instruct **Security** to establish control of treatment area.

   i. Assign a person to record radiological information and assist **Health Physics** as needed.

   j. Check radiation monitors, cover probes with rubber gloves or plastic bags and secure with tape and record background radiation levels in the decontamination room(s).

EMERGENCY MEDICAL SERVICE

1. Put on personal protective equipment and dosimeters before entering the radiation zone (record initial reading of dosimetry).

2. Prepare ambulance for receipt of patients by applying protective barrier covers.

3. Pick up radiation accident victims and decontaminate as appropriate. Wrap with sheets, if possible, to control contamination.

4. Report number of patients and nature of radiation accident to the ER.

5. Transport victims to designated hospital entrance (at VAH, east entrance to Animal Research Area), or as directed by the Emergency Center.

NOTE: **Patients will be transported to either UHC or VAH based on the following criteria regardless of contamination status:**

Class I, II to UHC
Class III to VAH
Non-injured to VAH

HEALTH PHYSICS SERVICE

1. Contact UM Radiation Safety Officer, 2-3721 and if campus reactor is involved, notify the Reactor Health Physics Manager, 2-4221.

2. Call Environmental Health and Safety and/or Business Office.

SECURITY

1. Dispatch Security Officers to ER to monitor and secure entry and exit of personnel.

2. Assist Emergency Center in setting up restriction barricades and restrict public access to the area.

3. Direct patients to the ER.

HOUSEKEEPING

1. Remove all hanging curtains from the treatment room.

2. Cut yellow herculite floor covering to fit the appropriate treatment room floor and secure with red duct tape.

3. Place brown paper on the floor half the widtn of the hall and 2 widths onto the ambulance unloading area. Tape the inside edges securely using the red duct tape and the outside edges with the yellow Radiation Tape.

4. Place the stretcher in the treatment room and the splash tray on top of the stretcher with fluid collection container.

5. After the patient is in the treatment room, place yellow herculite covering over the brown buffer zone paper and tape with yellow Radiation Tape.

6. Stand by for assistance in treatment room clean-up which will be directed by the Health Physics officer.

RADIOLOGY

Provide a radiologist-on-call in the absence of a Health Physicist to assist in the interpretation of radiation level measurements and ensure staff's protection. Nuclear medicine technicians with survey meters may serve as monitoring technicians. Radiation Physicist serves as competent Health Physicist during emergencies.

ADMISSIONS

Report to ER, providing emergency charts and ID bracelets.

PLANT ENGINEERING

Prepare to shut off air circulation system to prevent spread of contamination if directed to do so by the AOD or Command Center.

II. EQUIPMENT AND SUPPLY LIST

EMERGENCY SERVICES

A. Radiation Monitoring equipment (Barrels housed in Emergency Services area)

1. Survey meters
2. TLD badges
3. Pen dosimeters
4. Plastic Bags

5. Signs/Labels

B. General Equipment

Normal patient care and medical items.

HOUSEKEEPING

Usual housekeeping equipment and protective floor covering.

SECURITY

Barriers to control contaminated area

VA HOSPITAL

Two large drums containing Radiation Disaster supplies are stored in the VA research area and the VA shall be responsible for maintenance of the contents.

SUPPLY DISTRIBUTION

When requested, couriers will deliver supplies and decontamination beds(s) to designated areas.

III. PROCESS

HEALTH PHYSICIST, PARAMEDIC, EC or FLIGHT NURSE

A. Check patients for contamination with survey meters (preferably as patient is removed from the ambulance.

B. If seriously injured, give emergency lifesaving treatment immediately.

C. Handle contaminated patient with wound as one would a surgical procedure (i.e., gown, mask, cap, double gloves, etc).

D. If external contamination is involved, save all clothing and bedding from ambulance, blood, urine, stool, vomitus, and all metal objects with name, body location, time and date. Save each in appropriate containers; mark containers clearly, "Radioactive - Do Not Discard". Marking may be made with adhesive pasted to cloth bag or hamper inside of which is plastic disposable bag. Ambulance to be released by Health Physics before returning to service.

E. Decontamination should start, if medical status permits, with cleansing and scrubbing the area of highest contamination first. If an extremity alone is involved, clothing may serve as an effective barrier and the affected limb alone may be scrubbed and cleansed. Initial cleansing should be done with soap or detergent and warm water. Wash water may be flushed into community sewage system where dilution will obviate any hazardous effect. If the body as a whole is involved and clothing is generally permeated by contaminated material, showering and scrubbing will be necessary. Pay special attention to hairy parts, body orifices, and body folds. Decontamination of eyes, ears, nose, and mouth require irrigation with copious quantities of irrigation solution or water. Remeasure and record measurement after each washing or showering.

If a wound is involved, prepare and cover the wound with self-adhering disposable surgical drape. Cleanse neighboring surface of skin. Seal off cleansed areas with self-adhering disposable surgical drapes. Remove wound covering and irrigate wound with sterile saline, catching the irrigation fluid in a basin, and handle as described in item D above. Each step in the decontamination process should be preceded and followed by monitoring and recording of the location and extent of contamination.

F. Collect nurses', physicians', and attendants' scrubs or protective clothing, in plastic bags or waste barrels for monitoring by Health Physics. Nurses doctors, and attendants must follow the same monitoring and decontamination procedures to maintain contamination controls.

G. Request for additional supplies, equipment, and staffing should be arranged by the Emergency Center through the Command Center.

H. Admissions to floor beds, ICUs, OR will be coordinated through the Command Center, based on patient acuity, not primarily on contamination level.

J. If the physician in attendance in the Emergency Center is confronted with a grossly contaminated wound with dirt particles and crushed tissue, he/she should be prepared to do a preliminary simple wet debridement. An emergency minor surgical set would be used. Further measurements may necessitate sophisticated wound counting detection instruments supplied by a consultant who will advise if further definitive debridement is necessary.

NOTE: Health Physics Service personnel will serve as consultants in the event that radiation victims are treated at UHC. Their expertise includes the areas of:

- the use of radiation monitoring equipment;
- the logistical direction of patients treated and area to be utilized;
- directing the disposal of radioactive waste;
- directing the clean-up effort to ensure a radioactive-free environment. and
- assessing radiation doses of attending personnel.

IV. MUTUAL AGREEMENT

Mutual Agreement between Truman VA Hospital and University Hospital

1. The VA Hospital Associate Director-on-Call or the VA Medical Administrative Assistant is authorized to receive and act upon requests for aid from the AOD/Command Center. Upon approval, the VA representative will activate the Radiation Disaster Plan.

2. Each facility will be responsible for staffing their respective areas and ensuring that appropriate equipment, supplies, personal protective devices, environmental barriers, and monitoring equipment is available.

3. Each facility will store two, easily accessible, Radiation Disaster Response drums, properly maintained and labeled.

4. After decontamination, patients to be hospitalized will be transported through the VA/UHC tunnel to UHC. Patients requesting admission at the VA and fulfilling VA admission criteria will be admitted to the VA Hospital. All VA admissions will be communicated to the UHC Command Center.

5. Decontamination of each facility after victims have vacated the area will be supervised and directed by their respective Health Physics/Radiation Safety personnel who will then officially declare the area safe for resumption of routine activities.

6. Any victim that is dead on arrival or that expires during treatment will be transported to the VA Morgue.

VI. ALL CLEAR

AOD

Instruct Telecommunications to announce, or otherwise announce, "Radiation Emergency Action Plan All Clear."

MURR SITE EMERGENCY PROCEDURES AND
FACILITY EMERGENCY PROCEDURES

Revision Number 17

Revision Date: 8/25/94

EMERGENCY LOCKER INVENTORY
MURR COPY ROOM

Date _____

By _____

Number Required		Number Desired	
1	( )	2	flashlights - new batteries installed every 6 months. Date batteries when installing in flashlights.
1	( )	1	first aid kit
5	( )	5	"D" cell batteries replaced with new batteries every 6 months. Date batteries when placing in locker.
3	( )	5 boxes	swipes
0	( )	1 box	paper towels
0	( )	1 box	absorbent paper
2	( )	4 bars	face soap
3	( )	6	"Radioactive Material" tags
0	( )	2 rolls	tape
0	( )	1 roll	"Radioactive Material" tape
0	( )		assorted plastic bags
2	( )	4	NuCon permasigns
0	( )		NuCon permasign insets
1	( )	1 box	rubber gloves
4	( )	7 sets	protective clothing
0	( )	20 ft.	yellow and magenta rope
1	( )	1	Civil Defense instrument kit - date kit placed in cabinet _____

REMARKS: _____

_____

_____

_____

_____

_____

Rev. 8/25/94 App'd WWM

EMERGENCY LOCKER INVENTORY
RESEARCH PARK DEVELOPMENT BUILDING
(RPDB)

Date _____

By _____

Number Required		Number Desired	
1	( )	2	flashlights - new batteries installed every 6 months. Date batteries when installing in flashlights.
1	( )	1	first aid kit
5	( )	5	"D" cell batteries replaced with new batteries every 6 months. Date batteries when placing in locker.
3	( )	5 boxes	swipes
0	( )	1 box	paper towels
0	( )	1 box	absorbent paper
2	( )	4 bars	face soap
3	( )	6	"Radioactive Material" tags
0	( )	2 rolls	tape
0	( )	1 roll	"Radioactive Material" tape
0	( )		assorted plastic bags
2	( )	4	NuCon permasigns
0	( )		NuCon permasign insets
1	( )	1 box	rubber gloves
2	( )	2 sets	protective clothing
0	( )	20 ft.	yellow and magenta rope
1	( )	1	Civil Defense instrument kit - date kit placed in cabinet _____

REMARKS: _____

_____

_____

_____

_____

_____

Rev. 8/25/94 App'd _____

EMERGENCY PROCEDURES
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
J. Brake	**446-3026]**
L. Foyto	446-0491
J. Fruits	474-0774
A. Hartweg	474-7882
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	387-4859
T. Warner	816-882-6740

Health Physics/Rx. Chemistry

	Phone No.
J. Ernst	445-5621
J. Schuh	449-0992
R. Ayers	**443-6328]**
W. D. Pickett	474-0709
A. Shipp	442-4304
S. Keithley	**443-1929]**

Facilities Operations

	Phone. No.
C. Edwards	443-7529
D. Peeler	816-848-2471
K. Beamer	682-5499
R. Kitch	875-2045
C. Kribbs	682-3980
T. Seeger	474-3891
J. Baskett	474-2046
M. Richardson	446-1014

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. Storvick	445-4038
R. Dinger	449-0992
R. Stevens	442-2539]

Emergency Support Organizations

	Phone. No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital & Clinics	
Emergency Services	882-6003
Ambulance	882-6128 or 9-911
Walk-In (Emergency Center)	882-8091
UMC Health Physics (Office)	882-7221
Sue Langhorst (Home)	442-3534
Jamieson Shotts (Home)	474-2194
David Spate (Home)	657-9450
MU News Bureau	882-6211
See Public Information Procedure for other phone numbers (SEP-7).	882-9143 882-9144
State Emergency Management Agency (SEMA)	314-751-2748
NRC Washington, DC	301-816-5100
NRC Region III	708-829-9500
American Nuclear Insurers	203-561-3433

Rev. 8/25/94 App'd

MURR SITE EMERGENCY PROCEDURES AND
FACILITY EMERGENCY PROCEDURES

Revision Number 18

Revision Date: 12/20/94

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

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

   a. Verify radiation background at stack monitor.

   b. Verify control room readings.

   c. **Write down the readings on the** analog display, with the time, for future analysis if the control room display becomes inaccessible.

   d. Verify flow rate through monitor is 5 ± 1 SCFM. If not, use Worksheet A to determine stack monitor values.

6. If nuclides which are being released are in doubt, pull stack filters and analyze.

7. The Emergency Coordinator shall evaluate the need to evacuate specific portions of the facility.

8. The Emergency Coordinator shall appoint and have a surveillance team check any areas evacuated in step 7, 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.)

9. The Emergency Director shall determine the need for Emergency Support Organizations and, if needed, activate them or place them on standby. See Table II, Emergency Support Organizations.

   NOTE: If 9-911 is called during any emergency, contact MU News Bureau.

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. **Write down the readings on the** analog display, with **the** time, for future analysis if control room display becomes inaccessible.]

   d. Verify flow rate through monitor to 5 ± 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, 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 dewer; 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.

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. Write down the readings on the analog display, with the time, for future analysis if control room display becomes inaccessible.]

   d. Verify flow rate through monitor to 5 ± 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, 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 dewer; 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.

SEP-9

TRAINING PROCEDURE OF EMERGENCY PREPAREDNESS

I. TRAINING OF EMERGENCY ORGANIZATIONS

A. FACILITY EMERGENCY ORGANIZATION (FEO) TRAINING

This organization consists of MURR staff in the Director's Office, Operations, and Health Physics/Reactor Chemistry groups. This organization will respond to both General Facility Emergencies (Facility Evacuation, Reactor Isolation, Fire, Medical, and Security emergencies) and Emergencies with Possible Off-Site Consequences (Unusual Event, Alert, Site Area Emergency, Partial Site Area Evacuation).

1. The members of the FEO will train initially and annually thereafter, by emergency plan and procedure review of each member's role in emergency preparedness. This training will be documented by each member signing the Emergency Plan/Procedures Review Documentation List.

2. **An** annual on-site emergency **drill** shall be conducted as **an** action]
drill to test the training of FEO members to carry out their roles]
under simulated emergency conditions.

B. TRAINING OF FACILITY STAFF OTHER THAN FEO MEMBERS

1. The members of MURR staff not assigned to the FEO shall initially, and annually thereafter, be trained as to their respective actions for each site and facility emergency classification. This training may be by seminar, lecture, or video tape sessions.

2. **An** annual on-site emergency **drill** will test these members' ability to]
properly respond to simulated emergency conditions.

C. TRAINING OF EMERGENCY SUPPORT ORGANIZATIONS

1. The members of Emergency Support Organizations shall be trained initially, and biennially thereafter, on their role in maintaining emergency preparedness. This will be performed by discussions between MURR staff and the members of each Support Organization, stressing familiarization with the facility or **specific** changes to the Emergency]
Plan or Procedures **that may effect their response.** This training]
will be scheduled prior to each biennial drill and will include drill planning and scenario development.

2. **On a biennial basis, the annual** emergency **drill** shall be conducted]
to test, as a minimum, the communication link and notification procedures with these Emergency Support Organizations.

EMERGENCY PROCEDURES
EMERGENCY CALL LIST

Director's Office

	Phone No.
J. Rhyne	442-4967
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Reactor Operations

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J. Evans	**698-2127]**
R. Kitch	875-2045
C. Kribbs	314-682-3980]
S. Rinehart	**314-682-2807]**
T. Seeger	474-3891
J. Baskett	474-2046
M. Richardson	446-1014

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C. Baskett	474-2046
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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. Storvick	445-4038
R. Dinger	449-0992

Emergency Support Organizations

	Phone. No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital & Clinics	
Emergency Services	882-6003
Ambulance	882-6123 or 9-911
Walk-In (Emergency Center)	882-8091
UMC Health Physics (Office)	882-7221
Sue Langhorst (Home)	442-3534
Jamieson Shotts (Home)	474-2194
David Spate (Home)	657-9450
MU News Bureau	882-6211
See Public Information Procedure for other phone numbers (SEP-7).	882-9143
	882-9144
State Emergency Management Agency (SEMA)	314-751-2748
NRC Washington, DC	301-816-5100
NRC Region III	708-829-9500
American Nuclear Insurers	203-561-3433

Rev. 12/20/94 App'd

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

A. IMMEDIATE ACTIONS:

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.

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. 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.

I. PERSONNEL WITH PRE-ASSIGNED TASKS:
(Facility Emergency Organization members)

The following shall report to the lobby control center during normal working hours: Reactor Manager, Reactor Operations Engineer, Shift Supervisor, Duty Operator, Plant Engineer, Manager of Health Physics, Machine and Electronics Shop Supervisors.

The responsibilities of Emergency Director shall be assumed. The Emergency Director shall ascertain the availability of personnel required to execute the emergency plan. He shall investigate the cause of the alarm and the magnitude of the incident. He shall appoint an Emergency Coordinator.

If in the opinion of the Emergency Director the extent of the emergency is sufficient to warrant evacuation of the facility, he shall actuate the alarm and the facility evacuation plan shall be executed.

The Emergency Coordinator shall establish that containment is vacated and secured. He shall maintain a roster of all persons released from the site by the Emergency Director. He shall assist the Emergency Director as required and insure 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.
D. Ensure all personnel are cleared from all levels of the containment building and exit via personnel airlock door.

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

Section	Page Nos.	Revision No.	Revision Date
HP-6	1	1	5/31/94
HP-13	1	1	5/31/94
HP-14	1 - 2	2	11/29/94
HP-17	1 - 3	4	5/31/94
HP-28	1 - 6	3	8/12/94
HP-35	1 - 3	1	5/31/94
HP-39	1 - 6	1	8/12/94

The following HP-SOP procedures were deleted 6/2/94:

HP-5, Revision No. 1
HP-16, Revision No. 12
HP-23, Revision No. 2
HP-26, Revision No. 1

SOP HP-6

Rev. 1 Page 1 of 1

Appr'd Joe Ernst

Date 5/31/94

Air Sampling During Reactor Emergency

1.0 POLICY AND SCOPE

1.1 This procedure is used when the MURR Emergency Plan has been initiated and is performed to provide data for evaluations by the Emergency Director. Air samples will be collected and analyzed as per SEP-6.

1.2 This procedure may be used when air sampling is deemed necessary by the Reactor Manager or the Health Physics Manager.

2.0 PROCEDURE

2.1 Evacuate air sample can, if one of the cans is not currently evacuated, use Reactor Health Physics vacuum pump or equivalent (10^{-4} torr vacuum range).

2.2 Collect sample as per SEP-6.

2.3 Select counting station as following priority depending on availability.

A. Reactor Health Physics NaI counting well.

B. NaI detector--MCA system at Research Park Development Building.

2.4 Report analysis to Emergency Director.

SOP HP-13

Rev. 1 Page 1 of 1

Appr'd J. L. Ernst

Date 5/31/94

MURR Hot Cell Operation

1.0 POLICY

Use of the Hot Cell is restricted to persons who have received appropriate operational training from Service Applications Group and radiation protection instructions from Health Physics Group.

2.0 PURPOSE

The MURR Hot Cell is to be used to minimize radiation exposure to personnel.

3.0 RESPONSIBILITIES

3.1 Administrative responsibility for the Hot Cell is assigned to Manager, Reactor Health Physics.

3.2 The Manager, Reactor Health Physics is responsible for providing radiation protection as required for use of the Cell.

3.3 The Manager, Reactor Health Physics is responsible for determining that the exhaust filter system from the cell is adequate.

4.0 OPERATION OF THE CELL

4.1 Health Physics shall be informed prior to entry to the Cell.

A. Custody of the access door key shall remain with Health Physics.

4.2 The exhaust blower must be operating whenever the access door or pass-through are open.

4.3 Health Physics shall evaluate the airborne contamination hazard prior to entry to the cell.

SOP HP-14

Rev. 2 Page 1 of 2

Appr'd Joe Ernst

Date 11/29/94

CHANGING STACK MONITOR FILTERS

1.0 Purpose:

To replace the currently collecting particulate and charcoal filters with new ones. The particulate, iodine and gas monitors are source checked at this time, and the iodine high voltage is checked. These checks are to ensure the stack monitor is performing reliably between calibrations. This procedure does not apply to emergency or special situations involving these filters.

2.0 Preparation:

2.1 Collect a new particulate filter, a charcoal filter, the filter change-out book, a small plastic bag, a small envelope, and a volt meter.

2.2 Label the filters with the next consecutive number from the filter change-out book. Record these new numbers.

2.3 Ensure that no experimental or maintenance activities are being conducted which could likely result in the release of significant quantities of airborne radioactivity. The pneumatic tube system must not be in use during filter change. Call the control room and ask for their assistance in reading the control room recorder.

3.0 Procedure:

3.1 At the stack monitor, record the date, time and stack monitor pump flow rate in the filter change-out book. Ask for readings from the particulate, iodine and gas recorder in the control room. Record these values and compare them to the stack monitor meter readings.

3.2 Inform the operators that you are going to turn the pump off. Turn it off and record the time.

3.3 Remove the particulate filter holder from its housing. Place the particulate monitor standard (Cs-137) in its place. Remove the used particulate filter from the holder and place it in a small envelope giving care so that no particulate activity is lost. Replace the used

filter with a new, numbered filter, placing it rough side up on the holder.

3.4 Remove the charcoal (iodine) filter holder from its housing. Place the iodine monitor standard (Ba-133) in its place. Remove the used charcoal filter from the holder and place it in a small plastic bag. Replace the used filter with a new, numbered charcoal filter, placing it with the arrow on the side of the filter pointing into the holder.

3.5 When the particulate and iodine meter readings no longer seem to be increasing, call the control room for recorder readings. Compare these values to the values from the previous weeks. If they are not within twenty percent, inform the Manager of Health Physics.

3.6 Remove the particulate and iodine monitor standards and replace them with their respective filter holders.

3.7 Remove the plug to the gas monitor chamber and replace it with the gas monitor standard (Cs-137). While the meter value is levelling out, determine the iodine high voltage using the volt meter. Compare this voltage to the previous week's, inform the Manager of Health Physics if it has changed significantly.

3.8 Call the control room for the gas recorder reading. Compare this value to previous weeks. If it is not within twenty percent, inform the Manager of Health Physics. Remove the gas monitor standard and replace the plug for the gas monitor chamber.

3.9 Inform the control room that you are going to turn the pump back on. Check the flow rate, it should be close to the same value it was when the previous week's filter was started, and must be between 4.0 and 6.0 cfm. If the flow seems too high, turn the pump off again and check to make sure the particulate filter is secure in its holder. Record the time the pump was turned on and the flow rate. Inform the operators that you are finished changing stack filters.

3.10 Proceed with the Analysis of Particulate and Charcoal Stack Filters.

SOP HP-17

Rev. 4 Page 1 of 3

Appr'd Joe Ernst

Date 5/31/94

H-3 Air Samples

1.0 POLICY

An air sample measuring tritium levels in the containment building will be taken daily on normal working days or more often as may be deemed necessary.

2.0 PURPOSE

Ensure airborne tritium levels in containment building remain below regulatory limits.

3.0 EQUIPMENT

3.1 Gelman bubbler system or equivalent
1 ml pipette
Scintillation vials
Searle Delta 300 scintillation system or equivalent
Sample Bottle (> 250 ml)
250 ml graduated cylinder
Scintillation cocktail
Approved H-3 Standard

4.0 PROCEDURE

4.1 Place 250 ml distilled water in bubbler, secure top of bubbler.

4.2. Turn on air pump noting exact time.

4.3 Check air flow.

4.4 If necessary adjust air flow with black knobs to obtain air flow of three (3) liters per minute.

4.5 Allow to run for 60 to 120 minutes.

4.6 Secure air pump noting exact time.

4.7 Collect 250 ml tritiated water.

4.8 Add one (1) ml sample to 10 ml liquid scintillation cocktail in scintillation vial.

4.0 PROCEDURE (continued)

4.9 Swirl to mix until white precipitate dissolves.

4.10 Consecutively count sample mixture, prepared standard, and prepared black (for background counts) on Searle Delta 300 Liquid Scintillation System, or equivalent.

4.11 Delta 300 settings:

A. "Power" - on

B. "All samples" - green

C. "CPM" - white

D. "ESR" - white

E. Time knob - 10 minutes

F. 2 Sigma Knob - .25%

G. Module 1 inserted

(Caution--do not disturb if counting of another sample is in progress.)

5.0 CALCULATION

Sample count - blank +
standard count - blank count X
standard activity in µCi/cc X]
250 (liquid sample volume in ml) +
air volume (3000 ml/min X number of minutes sample ran) +
.9 (efficiency) = _____ µCi/cc H-3 in air]

Example:

sample count	130 CPM
standard count	1450 CPM
blank count	30 CPM
time sample run	60 minutes

5.0 CALCULATION (continued)

$$\left(\frac{100}{1420}\right) \times \left(1.64 \times 10^{-3}\right) \times (250) \div \left(1.8 \times 10^{5}\right) \div (.9)$$

$$= 1.8 \times 10^{-7} \ \mu Ci/cc$$

Note: 1.64×10^{-3} is and example of and H-3 standard activity.

SOP HP-28

Rev. 3 Page 1 of 6

Appr'd Jol Ernst

Date 8/12/94

Shipment of Radioactive Material, LSA Waste

1.0 Purpose and Scope

1.1 This procedure establishes the requirements for making exclusive use shipments of Low Specific Activity radioactive waste.

1.2 Individual responsible for making the waste shipment must have documented training meeting the requirements of 49 CFR 172 Subpart H.

1.3 Person responsible for this waste shipment _____.

1.4 Date of this waste shipment _____.

2.0 Procedure

2.1 Prerequisites:

_____ A. Notify MU Environmental Health and Safety of the Radioactive Waste Shipment.

_____ B. Material must not exceed the limits for a DOT Type A Quantity.

_____ C. Material must meet the definition of Radioactive Material - Low Specific Activity.

_____ D. Obtain a current copy of the recipients license and ensure that they are authorized to receive the quantity and form of radioactive material included in the shipment.

_____ E. Determine if any Licenses or Permits are necessary to transport waste through or into any states en route. If state specific permits/licenses are necessary ensure that they are obtained and valid for the intended shipment.

2.0 Procedure

2.1 Prerequisites (continued):

_____ F. If a Broker or Brokerage Service is utilized ensure that all necessary permits and licenses are possessed by the Broker. Ensure that the permits/licenses are valid and that the broker is authorized to utilize them.

2.2 Package Selection and Loading:

_____ A. Radioactive - LSA materials may be shipped exclusive use in strong tight containers (STC's). These containers must not leak radioactive material under conditions normally incident to transportation. Initialling on this space indicates that the package has been evaluated by MURR and that MURR has determined that it meets the definition of a strong tight container.

_____ B. Load the radioactive material into the strong tight container. Survey the material as it is loaded to ensure that package radiation levels will remain below the limits specified in 49 CFR 173.441. These limits specify that a package loaded in an exclusive use closed transport vehicle may exhibit a surface radiation level of 1000 mrem/hr provided the following conditions are met. The dose rate on the external surfaces of the vehicle may not exceed 200 mrem/hr. The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operates under provisions of a State or Federally regulated radiation protection program.

If the package is loaded onto an exclusive use open top vehicle then the package may exhibit a surface radiation level of only 200 mrem/hr. The other dose rate limits in the previous paragraph continue to apply.

2.0 Procedure

2.2 Package Selection and Loading (continued):

_____ C. Ensure that the material is blocked and braced or otherwise secured within the package to ensure that the lading will not shift under conditions normally incident to transportation.

_____QA

_____ D. Close the package using an appropriate closure device.

_____QA

_____ E. Visually inspect package to ensure that no damage has occurred during loading evolutions. Ensure the package still meets the requirements of a Strong Tight Container.

2.3 Package Survey:

_____ A. Perform a contamination survey on the package. Contamination levels on the external surfaces of the package should be less than 6600 dpm/300 cm^2 Beta/ Gamma and less than 660 dpm/300 cm^2 Alpha.

_____ B. Perform a radiation level survey on all sides, including the top and bottom of the package. External radiation levels must comply with 49 CFR 173.441. These limits specify that a package loaded in an exclusive use closed transport vehicle may exhibit a surface radiation level of 1000 mrem/hr provided the following conditions are met. The dose rate on the external surfaces of the vehicle may not exceed 200 mrem/hr. The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operates under provisions of a State or Federally regulated radiation protection program.

_____QA

2.0 Procedure

2.3 Package Survey (continued):

If the package is loaded onto an exclusive use open top vehicle then the package may exhibit a surface radiation level of only 200 mrem/hr. The other dose rate limits in the previous paragraph continue to apply.

Document this survey on a MURR survey form. Measure the Transport Index (TI) of the package.

2.4 Package Marking and Labeling:

_____ A. Package shall be marked as "Radioactive - LSA". The packages are excepted from all specification labelling.

_____ B. Packages should have gross weight marked on the container.

2.5 Loading the Package on to the Conveyance:

_____ A. Package shall be loaded onto the vehicle by the consignor.

_____ B. Package shall be braced on the vehicle to prevent shifting during normal transportation conditions.

_____ C. There shall be no loose radioactive material in the conveyance.

_____ D. Perform a vehicle Radiation Survey. The dose rate on the external surfaces of the vehicle may not

_____QA exceed 200 mrem/hr. The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operating under provisions of a State or Federally regulated radiation protection program.

2.0 Procedure

2.5 Loading the Package on to the Conveyance (continued):

_____ E. Perform a vehicle contamination survey. Contamination levels on the vehicle shuld be less than 660 dpm/300 cm^2 Beta/Gamma and less than 66 dpm/300 cm^2 Alpha.

2.6 Placard the Vehicle

_____ A. Transport vehicle must bear the Radioactive Placards on all four sides.

2.7 Shipping Papers:

_____ A. Prepare a bill of lading and have it reviewed by a Certified Shipper.

_____Certified Shippers Initials.

_____ B. The following reports shall accompany all shipments: Radioactive Shipment Manifest (RSM), Vehicle Radiation Survey, Bill of Lading, Emergency Response Guide and Exclusive Use Instructions.

2.8 Shipment Release

_____ A. Notify the consignee that the radioactive material shipment is taking place. This notification may be made by telephone call or by FAX.

Shipment approved for release by:

_____/_____
Signature / Date

_____ B. Package released to carrier.

2.0 Procedure (continued)

2.9 Emergency Response Information

_____ A. Deliver a copy of the Bill of Lading, RSM and Emergency Response Guide to the Control Room Emergency Response Book.

SOP HP-35

Rev. 1 Page 1 of 3

Appr'd John Ernst

Date 5/31/94

BEAMPORT AREA ACCESS

1.0 POLICY

Unescorted entry into the beamport area shall be limited to those individuals approved for access to the area. All other individuals entering the beamport area shall be escorted by individuals with approved access.

2.0 PURPOSE

The purpose of controlling access to the beamport area is to ensure compliance with 10 CFR 20.1601: "Control of access to high radiation areas."]

3.0 DEFINITIONS

3.1 **Authorized Individual** means any individual who is identified as having need of access to the beamport area, and who has successfully completed training and been approved for unescorted access.

3.2 **Beamport Area** is defined as that area around the biological shielding controlled by fencing with key access.

3.3 **High Radiation Area** means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.]

3.4 **Radiation area** means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.]

4.0 RESPONSIBILITIES

4.1 Access Control

A. Limited to authorized individuals.

4.1 Access Control (continued)

B. Guests approved by Health Physics prior to escorted entry by an authorized individual.

C. Access control required during reactor operation.

D. List of authorized individuals maintained at each access point.

E. Authorized individuals responsible for ensuring positive control of each entry.

4.2 Training

A. Initial request made to Health Physics by sponsor to complete training of individual to be authorized.

B. Successful completion of training and approval for individual to be authorized as per TRAINING 2: "General Information for Beamport Area Access - Radiation Safety."

4.3 Door Control

A. During reactor operation, doors shall remain locked except during periods when access to the area is required, with positive control over each entry.

B. During reactor shutdown, doors may be opened to individuals with containment access unless special maintenance procedures warrant limited access.

C. Reactor Operations will ensure doors are closed prior to reactor startup.

4.4 Posting

A. Entry points to the beamport area shall be posted as per 10 CFR 20.1902(b) with the phrase, "in the beam", added.]

B. High radiation areas shall be limited to in the neutron beams during normal operation.

4.4 Posting (continued)

C. Neutron beams accessible to personnel shall be conspicuously marked with yellow plastic streamers.

4.5 Radiation Surveys

A. Beamport area shall be included in the monthly survey of the beamport floor performed by Health Physics

B. Copies of the monthly area surveys are posted on the beamport floor bulletin board and should be reviewed by the authorized individuals.

C. Survey instruments are available for authorized individuals to make radiation measurements.

D. Changes or movement of the physical arrangement of the instruments, beam stops, and shielding shall be done in cooperation with Health Physics to monitor for changes in dose rates or contamination.

E. Items removed from the beamport area suspected to be activated and/or contaminated shall be monitored by Health Physics prior to being released or stored.

SOP HP-39

Rev. 1 Page 1 of 6

Appr'd. Joe Ernst

Date 8/12/94

Shipment of Radicactive Material NOS Waste

1.0 Purpose and Scope

1.1 This procedure establishes the requirements for making exclusive use shipments of radioactive material, n.o.s.,waste.

1.2 Individual responsible for making the waste shipment must have documented training meeting the requirements of 49 CFR 172 Subpart H.

1.3 Person responsible for this waste shipment _____.

1.4 Date of this waste shipment _____.

2.0 Procedure

2.1 Prerequisites:

_____ A. Notify MU Environmental Health and Safety of the Radioactive Waste Shipment.

_____ B. Material must not exceed the limits for a DOT Type A Quantity. Type B quantities must be covered by an approved Quality Assurance Program Procedure.

_____ C. Obtain a current copy of the recipients license and ensure that they are authorized to receive the quantity and form of radioactive material included in the shipment.

_____ D. Determine if any Licenses or Permits are necessary to transport waste through or into any states en route. If state specific permits/licenses are necessary ensure that they are obtained and valid for the intended shipment.

2.0 Procedure

2.1 Prerequisites (continued):

_____ E. If a Broker or Brokerage Service is utilized ensure that all necessary permits and licenses are possessed by the Broker. Ensure that the permits/licenses are valid and that the broker is authorized to utilize them.

2.2 Package Selection and Loading:

_____ A. Type A Quantities of Radioactive material, n.o.s. may be shipped in DOT Specification 7A packaging. The performance and environmental testing or evaluation shall meet DOT 7A requirements. Initialling on this space indicates that the package has been evaluated by MURR and that MURR has determined that it meets the definition of a DOT Specification 7A container.

_____ B. Load the radioactive material into the container. Survey the material as it is loaded to ensure that package radiation levels will remain below the limits specified in 49 CFR 173.441. These limits specify that a package loaded in an exclusive use closed transport vehicle may exhibit a surface radiation level of 1000 mrem/hr provided the following conditions are met. The dose rate on the external surfaces of the vehicle may not exceed 200 mrem/hr The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operates under provisions of a State or Federally regulated radiation protection program.

If the package is loaded onto an exclusive use open top vehicle then the package may exhibit a surface radiation level of only 200 mrem/hr. The other dose rate limits in the previous paragraph continue to apply.

2.0 Procedure

2.2 Package Selection and Loading (continued):

_____ C. Ensure that the material is blocked and braced or otherwise secured within the package to ensure
_____QA that the lading will not shift under conditions normally incident to transportation.

_____ D. Close the package using an appropriate closure device.
_____QA

_____ E. Visually inspect package to ensure that no damage has occurred during loading evolutions.

2.3 Package Survey:

_____ A. Perform a contamination survey on the package. Contamination levels on the external surfaces of the package should be less than 660 dpm/300 cm^2 Beta/Gamma and less than 66 dpm/300 cm^2 Alpha.

_____ B. Perform a radiation level survey on all sides, including the top and bottom of the package.
_____QA External radiation levels must comply with 49 CFR 173.441. These limits specify that a package loaded in an exclusive use closed transport vehicle may exhibit a surface radiation level of 1000 mrem/hr provided the following conditions are met. The dose rate on the external surfaces of the vehicle may not exceed 200 mrem/hr. The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operates under provisions of a State or Federally regulated radiation protection program.

2.0 Procedure

2.3 Package Survey (continued):

If the package is loaded onto an exclusive use open top vehicle then the package may exhibit a surface radiation level of only 200 mrem/hr. The other dose rate limits in the previous paragraph continue to apply.

Document this survey on a MURR survey form. Measure the Transport Index (TI) of the package.

2.4 Package Marking and Labeling:

_____ A. Package shall be labelled in accordance with 49 CFR 172.403.

_____ B. Package shall be marked with the container certification (i.e. USA DOT 7A Type A).

_____ C. Packages shall have gross weight marked on the container.

_____ D. Packages shall be marked with the proper shipping name and identification (UN number).

2.5 Loading the Package on to the Conveyance:

_____ A. Package shall be loaded onto the vehicle by the consignor.

_____ B. Package shall be braced on the vehicle to prevent shifting during normal transportation conditions.

_____ C. There shall be no loose radioactive material in the conveyance.

2.0 Procedure

2.5 Loading the Package on to the Conveyance (continued):

_____ D. Perform a vehicle radiation survey. The dose rate on the external surfaces of the vehicle may

_____QA not exceed 200 mrem/hr. The dose rate at 2 m from the outer lateral surfaces of the vehicle may not exceed 10 mrem/hr. The dose rate in any normally occupied region of the vehicle may not exceed 2 mrem/hr unless you have a private carrier with the exposed personnel wearing radiation dosimetry devices and the carrier operating under provisions of a State or Federally regulated radiation protection program.

Document this survey on a MURR survey form. Be sure to include the dose rate at 2m and the cab dose rate on survey form

_____ E. Perform a vehicle contamination survey. Contamination levels on the vehicle should be less than 660 dpm/300 cm^2 Beta/Gamma and less than 66 dpm/300 cm^2 Alpha

2.6 Placard the Vehicle

_____ A. Transport vehicle must bear the Radioactive Placards on all four sides if the package required a Yellow III label.

2.7 Shipping Papers:

_____ A. Prepare a bill of lading and have it reviewed by a Certified Shipper.

_____Certified Shippers Initials.

_____ B. The following reports shall accompany all shipments: Radioactive Shipment Manifest (RSM), Vehicle Radiation Survey, Bill of Lading and Emergency Response Guide. Exclusive Use Instructions shall be provided to the driver if the load is shipped exclusive use.

2.0 Procedure (continued)

2.8 Shipment Release

_____ A. Notify the consignee that the radioactive material shipment is taking place. This notification may be made by telephone call or by FAX.

Shipment approved for release by:

_____/___ _____
Signature / Date

_____ B. Package released to carrier.

2.9 Emergency Response Information

_____ A. Deliver a copy of the Bill of Lading, RSM and Emergency Response Guide to the Control Room Emergency Response Book.

Page Number

2.0 SERVICE APPLICATIONS-SHIPPING: PRECAUTIONS AND LIMITATIONS

2.1 The non-fixed contamination on any external surface of the transfer cask, work tables, floors, 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, follow directions on monitors and call Health Physics immediately.

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
- 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.

2.10 In the event of a stuck capsule or broken vial, the Reactor Services Engineer or Designee must be notified immediately.

2.11 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).

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

2.12 Applicable container specifications must be specified by purchase order.

2.12.1 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.

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

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

2.15 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.

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

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

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

2.17 Air Freight Shipment quantity limits shall be in accordance with the Requirements of 49CFR and IATA Regulations.

2.18 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.

2.18.1 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.

2.19 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.

2.20 Ensure that all beta-gamma dose rate survey equipment and meter stick calibration stickers have not passed the calibration due date prior to use.

2.21 The requirements for each package containing fissile material shall comply in accordance with 49CFR.

2.22 Shipping activity: The Irradiation Project Specialist or his designee is responsible for the activity listed on all shipments and should report all radionuclides to the 90th percentile of activity at the time of shipment.

2.22.1 In the absence of the Irradiation Project Specialist, the following individuals are qualified to approve shipment activities;

- Processing Project Specialist
- Service Applications Engineer
- Manager Health Physics
- Project Specialist of Radio pharmaceuticals

2.22.2 The Irradiation Project Specialist may designate a list of samples by company and target, whose activity may be derived by means of Capintec or equivalent measurement.

2.22.3 The Irradiation Project Specialist may designate a list of individuals who are authorized to approve shipment activity for secondary samples.

3.0 SERVICE APPLICATIONS-SHIPPING: DEFINITIONS

3.1 A1: The maximum activity of " SPECIAL FORM" Radioactive material permitted in a Type A package.

3.1.1 Values of A1 for most Radionuclides are given in 49CFR and IATA Regulations.

3.2 A2: The maximum activity of Radioactive material, other than "Special Form" Radioactive material, permitted in type A package.

3.2.1 Values of A2 for most Radionuclides are given in Tables of 49CFR and IATA Regulations.

3.3 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.

3.4 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.

3.4.1 Gigabecquerel (GBq): One GBq = 1,000,000,000 Bq or $1E^{9}$ Bq.

3.4.2 Terabecquerel (TBq) : One TBq = 1,000,000,000,000 Bq or $1E^{12}$ Bq.

3.4.3 The Bq replaces the older unit for activity, the Curie (Ci).

3.4.4 One Ci is equal to 37 GBq.

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

3.5.1

To convert	To	Multiply by:
Ci	GBq	37.00
TBq	Ci	27.03

3.6 Experiment: Is any device or material which is exposed to significant radiation from the reactor and is not a normal part of the reactor or any operation designed to measure or monitor reactor characteristics or parameters.

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

3.8 Externally contaminated objects of non-radioactive material 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.

3.9 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.

3.10 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.

3.11 Host Capsule Change Sheet: This term is used in the Description Section of the Sample Shipment Information Sheet. It is an interchangeable title for the Existing Loading Sheet.

3.12 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.

3.13 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.

3.14 Low Specific Activity Material (LSA) means any of the following:

3.14.1 Uranium or thorium ores and physical or chemical concentrates of those ores.

3.14.2 Unirradiated natural or depleted uranium or unirradiated natural thorium.

3.14.3 Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.

3.14.4 Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration of contents does exceed:

3.14.4.1 0.0001 millicurie per gram of Radionuclides for which the A2 quantity is not more than .05 curie;

3.14.4.2 0.005 millicurie per gram of Radionuclides for which the A2 is more than .05 curie, but not more than 1 curie; or

3.14.4.3 0.3 millicurie per gram of Radionuclides for which the A2 quantity is more than 1 curie.

3.15 MCA: Multi-Channel Analyzer

3.16 Non-fixed Radioactive Material: Radioactive contamination that can be removed from a surface by wiping with a dry smear.

3.17 Normal Form Radioactive Material: Radioactive Material which has not been Qualified as " Special Form" Radioactive Material.

3.18 Observer/Inspector: 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.

3.19 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.

3.20 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:

3.20.1 White I = The maximum radiation level at any point on the external surface is 0.5 mrem/hr. The Transport Index is not applicable.

3.20.2 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.

3.20.3 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.

3.20.3.1 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.

3.20.4 Packages and overpacks shall be assigned to Category White I, Yellow II, or Yellow III in accordance with 49CFR and IATA Dangerous Goods Regulations.

3.20.5 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).

3.21 Primary Processed Samples: Samples that have been under continuous SAS Control after removal from reactor.

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

3.23 Radioactive material:

3.23.1 DOT: Any material having a specific activity greater than 0.002 micro curies per gram (uCi/g).

3.23.2 NRC: "Specific activity" of a radionuclide, means the activity of the radionuclide per unit mass of that nuclide.

The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

3.24 Sample: Is a chemical or physical makeup of the target material or combination of target and encapsulation.

3.25 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.

3.25.1 "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.

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

3.25.1.2 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.

3.25.1.3 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.

3.26 Secondary Processed Samples: Samples that are directly submitted for shipping by RPG, NAP or HP.

3.27 Shall, Must, Should:

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

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

3.27.3 Should: Should be accomplished; not required.

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

3.29 Spacer: Used to take up space in the host can to minimize capsule movement.

3.30 Special Form Radioactive Material: Radioactive Material is either an in-dispersible solid Radioactive Material or a sealed capsule containing Radioactive Material.

3.30.1 Special Form Radioactive Material shall meet the requirements of 49CFR and IATA Regulations.

3.30.1.1 If it is in a sealed capsule, that capsule shall be so constructed that it can only be opened by destroying.

3.30.1.2 The Special Form Radioactive Material shall have at least one dimension not less than 5 mm.

3.30.1.3 The Special Form design shall have received unilateral approval.

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

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

3.32.1 Orange Roll Up cask is included as a transfer cask.

3.33 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.

3.33.1 The TI number is determined by 49CFR and IATA Regulations.

3.33.2 The transport index is determined as follows:

3.33.2.1 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,

3.33.2.2 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.

3.34 Type A Packaging: A type "A" package must not contain activities greater than the following:

3.34.1 For "Special Form" Radioactive Material the value of A1 is listed in Tables of 49CFR and IATA Regulations.

3.34.2 For other Radioactive Material the value of A2 is listed in Tables of 49CFR and IATA Regulations.

3.35 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.

MURR SHIPPING PROCEDURES*

MURR-SAS-00004

Revision Number	Revision Date	Page Number
2	9/27/94	6 of 31
2	9/27/94	8 of 31
3	11/4/94	10 of 31
2	9/27/94	13 of 31
2	9/27/94	14 of 31
2	9/27/94	15 of 31
2	9/27/94	16 of 31
2	9/27/94	17 of 31
2	9/27/94	18 of 31
2	9/27/94	19 of 31
3	11/4/94	23 of 31
3	11/4/94	25 of 31
2	9/27/94	27 of 31
3	11/4/94	28 of 31
2	9/27/94	30 of 31
2	9/27/94	31 of 31
3	11/4/94	MURR Model 1000 Checksheet, page 1 of 2
3	11/4/94	MURR Model 1000 Checksheet, page 2 of 2
3	11/4/94	MURR Model 1100 Checksheet, page 1 of 2
3	11/4/94	MURR Model 1100 Checksheet, page 2 of 2
3	11/4/94	MURR Model 1220 Checksheet, page 1 of 2
3	11/4/94	MURR Model 1220 Checksheet, page 2 of 2
3	11/4/94	MURR Model 1300 Checksheet, page 1 of 2
3	11/4/94	MURR Model 1300 Checksheet, page 2 of 2

*Note: Complete procedure is reissued with each revision, so all pertinent changes from each revision in 1994 have been copied from the latest revision.

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.

| 2.12 Shipping activity: The Irradiation Section Leader or his designee is responsible for the activity listed on all shipments and should report all radionuclides to the 90th percentile of activity at the time of shipment.

| 2.12.1 In the absence of the Irradiation Section Leader, the following individuals are qualified to approve shipment Activities;

| • Processing Section Leader
• Service Applications Engineer
• Manager Health Physics
| • Section Leader of Radio pharmaceuticals

| 2.12.2 The Irradiation Section Leader may designate a list of samples by company and target, whose activity may be derived by means of Capintec or equivalent measurement.

| 2.12.3 The Irradiation Section Leader may designate a list of individuals who are authorized to approve shipment activity for measured secondary samples.

3.12 DOT- 12B40 boxes with the following information:

3.12.1 Label:

USA DOT 7A 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.

4.7.5 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 Primary Processed Samples: Samples that have been under continuous SAS Control after removal from reactor.

4.11 Secondary Processed Samples: Samples submitted for shipment by groups other than Service Applications.

4.12 Shipping Technician (Shipper) is defined to be any person in the Shipping Group:

4.12.1 Shipper, Trainee: Can neither Perform or Inspect a Task.

4.12.2 Shipper, Qualified: Is an individual who has completed the Required Documented Training to perform a specific Task.

4.12.3 Shipper, Certified: Is Qualified to perform all aspects of Shipping as documented by Training.

4.13 Special Form Radioactive Material: Radioactive Material is either an in-dispersible solid Radioactive Material or a sealed capsule containing Radioactive Material.

4.13.1 Special Form Radioactive Material shall meet the requirements of 49CFR and IATA Regulations.

4.13.1.1 If it is in a sealed capsule, that capsule shall be so constructed that it can only be opened by destroying.

4.13.1.2 The Special Form Radioactive Material shall have at least one dimension not less than 5 mm.

4.13.1.3 The Special Form design shall have received unilateral approval.

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

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

4.20.2 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 or #2 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 # 151313.
- The Wunderlich box is sealed with 3" Scotch brand tape type 3M-355 or brown Safety Tape.

4.20.3 Packaging Procedure:

- Sample is placed in lead pig.
- 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 or #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 brand tape type 3M-355 or brown Safety Tape to all seams.

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

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

4.21.2 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 polystyrene #1 or #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 Miller-Bevco 9 mm strapping # 06MG0912998WH.
- The polystyrene is inserted in a Wunderlich #40UN151313.
- The Wunderlich box is sealed with 3" Scotch brand tape type 3M-355 or brown Safety Tape.

4.21.3 Packaging Procedure:

- Sample is placed in secondary containment.
- The secondary containment is sealed by Bron 1" tape 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 #1 or # 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 or brown Safety Tape to all seams.

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

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

4.22.2 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 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 or #2 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 9mm strapping # 06MG0912998WH.
- The polystyrene is inserted in a Wunderlich box # 40UN151313.
- The Wunderlich box is sealed with 3" scotch brand tape type 3M-355 or brown Safety Tape.

4.22.3 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 or #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 brand tape Type 3M- 355 or brown Safety Tape to all seams.

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

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

4.23.2 Description of Package:

- Sample is 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 or #2 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 Wunderlich box # 40UN151313.
- The Wunderlich box is sealed with 3" Scotch tape type 3M-355 or brown Safety Tape.

4.23.3 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 or #2 packing inserts with fiberboard endcaps.
- The polystyrene is secured by four crossing Miller 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 or brown Safety Tape to all seams.

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 PACKET

A Qualified Shipper will prepare the Package Packet:

7.3.1 Determine the proper Shipping Container based on information from Sections 4.20, 4.21, 4.22 or 4.23 (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. 65211

7.3.2.4 Two each: Radioactive Material
N.O.S. UN2982

7.3.3 Prepare "Control Check Sheet" for proper USA DOT 7A 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 "

7.5.11 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 opposite sides of the 7A container.

7.5.18.1 Include "RQ" before or after if applicable.

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^2) 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.

7.10 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 * Verify that activity has been approved as per Precautions and Limitations of MURR-SAS-00004, Step 2.12.

7.10.3.3 * Isotope and activity is within acceptable limits and possession limits.

7.10.3.4 * The shipping address is correct.

7.10.3.5 * Transfer Form is in packing enclosure.

7.10.3.6 * 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) indicating shipment is approved for release.

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 and Handling Label adjacent to the Primary Hazard Label.

7.12.2.6 Include "RQ" before or after if applicable.

7.12.3 Certified Shipper signs and dates Control Check Sheet attachment 4) indicating shipment is approved for release.

7.16 RELEASE TO COURIER

7.16.1 Mark the box below the Certified Shipper's Signature/Date (Attachment 4) only if the package is category Yellow III, and requires vehicle placards.

7.16.2 Package is picked up and signed for by a Courier only if the package is a yellow III indicating an offer was made to the courier for placards.

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) will be initialed and method of notification noted.

ATTACHMENTS

A. Packaging Flow Chart (Attachment 1).

B. In-House Radioactive Shipping Request Form (Attachment 2).

C. Request for Radioisotope Shipment Form (Attachment 3).

D. Control Check Sheets for USA DOT MURR Models (Attachment 4).

E. Address Label Examples (Attachment 5).

F. Material Transfer Form (Attachment 6).

G. Shippers Declaration For Dangerous Goods Form (Attachment 7a).

H. Straight Bill of Lading (Attachment 7b).

I. Shipping Summary Form (Attachment 8).

REFERENCES

A. Federal Code of Regulations 49CFR.

B. Federal Code of Regulations 10CFR.

C. International Air Transport Association Dangerous Goods Regulations.

CONTROL CHECK SHEET FOR USA DOT 7A
MURR MODEL 1000

Performer and Inspector can not be the same individual.

Affix shipment preprinted identification label here.
(Shipment Destination, Isotope(s), MURR Identification Number(s), and Activity)

Inspector	Performer		
_____	_____	1.	Lead shipping pig and inner shipping can identification labels agree.
_____	_____	2.	Inner shipping can sealed.
	_____	3.	Radioactive labels on inner shipping can.
_____	_____	4.	Expanded polystyrene insert identified and strapped.
_____	_____	5.	7A container identified, sealed and strapped.
	_____	6.	Security seals on 7A container.
	_____	7.	Certification label in place on 7A container.
	_____	8.	Proper shipping name and UN No. on opposite sides of the 7A container. (Include "RQ" before or after if applicable)
	_____	9.	7A container swipe <6600 dpm/300cm^2 $\beta\gamma$ & <660 dpm/300cm^2 α.
_____	_____	10.	7A container dose survey (mR/hr):
			Contact: T: _____ B:_____ Sides: 1)_____ 2)___ 3)____ 4)____
			Transport Index: _____
		11.	Verify the information for this shipment is specified in the MURR Irradiation/Shipment request form and is within the license restrictions.
	_____		a. License number, amendment number and expiration date agree.
	_____		b. Verify that activity has been approved as per Precautions and Limitations of MURR-SAS-00004 (2.12).
	_____		c. Isotope and activity is within acceptable limits and possession limits.
	_____		d. The shipping address is correct.
	_____	12.	Transfer Form is in packing enclosure.

Note: ***Performer is to list information from each label. (The performer should not be the shipper releasing the container.)***

Inspector	Performer		
_____	_____	13.	Primary hazard labels verified and in place on opposite sides of the 7A container.
			Category: _____ _____
			Isotope(s): _____ _____
			Activity: _____ _____
			TI: _____ _____
_____	_____	14.	Verify appropriate subsidiary risk and handling label(s) are adjacent to the primary hazard labels (List). (Include "RQ" before or after if applicable)
			_____ _____ _____
_____	_____	15.	Shipment Waybill(s), address label and 7A container preprinted identification label agree.
	_____	16.	Sodium Iodide Spectrum completed.
	_____	17.	Consignee notified of shipment.

Shipment approved for release by:

_____
Certified Shipper's Signature/Date

☐ **This package is categor; Yellow III, and requires vehicle placards.**

I accept this shipment and certify that I have been offered radioactive placards, for Yellow III only, at the time it was offered for transport.

_____
Courier's Signature/Date

CONTROL CHECK SHEET FOR USA DOT 7A
MURR MODEL 1100

Performer and Inspector can not be the same individual.

Affix shipment preprinted identification label here.
(Shipment Destination, Isotope(s), MURR Identification Number(s), and Activity)

Inspector	Performer		
	_____	1.	Kimpack® material in inner shipping can. (1gm/2ml) No. of mls._ No. of grams of Kimpack®_____
_____	_____	2.	Lead shipping pig and inner shipping can identification labels agree.
_____	_____	3.	Inner shipping can sealed.
	_____	4.	Radioactive labels on inner shipping can.
_____	_____	5.	Expanded polystyrene insert identified and strapped.
_____	_____	6.	7A container identified, sealed and strapped.
	_____	7.	Security seals on 7A container.
	_____	8.	Certification label in place on 7A container.
	_____	9.	Proper shipping name and UN No. on opposite sides of the 7A container. (Include "RQ" before or after if applicable)
	_____	10.	7A container swipe <6600 dpm/300cm^2 $\beta\gamma$ & <660 dpm/300cm^2 α.
_____	_____	11.	7A container dose survey (mR/hr): Contact: T: _____ B:_____ Sides: 1)_____ 2)____ 3)____ 4)____ Transport Index: _____
		12.	Verify the information for this shipment is specified in the MURR Irradiation/Shipment request form and is within the license restrictions.
	_____		a. License number, amendment number and expiration date agree.
	_____		b. Verify that activity has been approved as per Precautions and Limitations of MURR-SAS-00004 (2.12).
	_____		c. Isotope and activity is within acceptable limits and possession limits.
	_____		d. The shipping address is correct.
	_____	13.	Transfer Form is in packing enclosure.

Note: ***Performer is to list information from each label. (The performer should not be the shipper releasing the container.)***

Inspector	Performer		
_____	_____	14.	Primary hazard labels verified and in place on opposite sides of the 7A container.
			Category: _____ _____
			Isotope(s): _____ _____
			Activity: _____ _____
			TI: _____ _____
_____	_____	15.	Verify appropriate subsidiary risk and handling label(s) are adjacent to the primary hazard labels (List). (Include "RQ" before or after if applicable)
			_____ _____ _____
_____	_____	16.	Shipment Waybill(s), address label and 7A container preprinted identification label agree.
	_____	17.	Sodium Iodide Spectrum completed.
	_____	18.	Consignee notified of shipment.

Shipment approved for release by:

_____

Certified Shipper's Signature/Date

☐ **This package is category Yellow III, and requires vehicle placards.**

I accept this shipment and certify that I have been offered radioactive placards, for Yellow III, at the time it was offered for transport.

_____

Courier's Signature/Date

CONTROL CHECK SHEET FOR USA DOT 7A
MURR MODEL 1220

Performer and Inspector can not be the same individual.

Affix shipment preprinted identification label here.
(Shipment Destination, Isotope(s), MURR Identification Number(s), and Activity)

Inspector	Performer		
	_____	1.	Kimpack® 80 packet used in inner shipping can.
_____	_____	2.	Lead shipping pig and inner shipping can identification labels agree.
_____	_____	3.	Inner shipping can sealed.
	_____	4.	Radioactive labels on inner shipping can.
_____	_____	5.	Expanded polystyrene insert identified and strapped.
_____	_____	6.	7A container identified, sealed and strapped.
	_____	7.	Security seals on 7A container.
	_____	8.	Certification label in place on 7A container.
	_____	9.	Proper shipping name and UN No. on opposite sides of the 7A container. (Include "RQ" before or after if applicable)
	_____	10.	7A container swipe <6600 dpm/300cm^2 $\beta\gamma$ & <660 dpm/300cm^2 α.
_____	_____	11.	7A container dose survey (mR/hr):
			Contact: T: _____ B:_____ Sides: 1)_____ 2)____ 3)____ 4)____
			Transport Index: _____
		12.	Verify the information for this shipment is specified in the MURR Irradiation/Shipment request form and is within the license restrictions.
	_____		a. License number, amendment number and expiration date agree.
	_____		b. Verify that activity has been approved as per Precautions and Limitations of MURR-SAS-00004 (2.12).
	_____		c. Isotope and activity is within acceptable limits and possession limits.
	_____		d. The shipping address is correct.
	_____	13.	Transfer Form is in packing enclosure.

Note: ***Performer is to list information from each label. (The performer should not be the shipper releasing the container.)***

Inspector	Performer		
_____	_____	14.	Primary hazard labels verified and in place on opposite sides of the 7A container.
			Category: _____ _____
			Isotope(s): _____ _____
			Activity: _____ _____
			TI: _____ _____
_____	_____	15.	Verify appropriate subsidiary risk and handling label(s) are adjacent to the primary hazard labels (List). (Include "RQ" before or after if applicable)
			_____ _____ _____
_____	_____	16.	Shipment Waybill(s), address label and 7A container preprinted identification label agree.
	_____	17.	Sodium Iodide Spectrum completed.
	_____	18.	Consignee notified of shipment.

Shipment approved for release by:

_____
Certified Shipper's Signature/Date

☐ **This package is a category Yellow III, and requires vehicle placards.**

I accept this shipment and certify that I have been offered radioactive placards, for Yellow III only, at the time it was offered for transport.

_____
Courier's Signature/Date

CONTROL CHECK SHEET FOR USA DOT 7A
MURR MODEL 1300

Performer and Inspector can not be the same individual.

Affix shipment preprinted identification label here.
(Shipment Destination, Isotope(s), MURR Identification Number(s), and Activity)

Inspector	Performer	
_____	_____	1. Sample containment and inner shipping can identification labels agree.
_____	_____	2. Inner shipping can sealed.
_____		3. Radioactive labels on inner shipping can.
_____	_____	4. Expanded polystyrene insert identified and strapped.
_____	_____	5. 7A container identified, sealed and strapped.
	_____	6. Security seals on 7A container.
	_____	7. Certification label in place on 7A container.
	_____	8. Proper shipping name and UN No. on opposite sides of the 7A container. (Include "RQ" before or after if applicable)
	_____	9. 7A container swipe <6600 dpm/300cm^2 $\beta\gamma$ & <660 dpm/300cm^2 α.
_____	_____	10. 7A container dose survey (mR/hr):
		Contact: T: _____ B:_____ Sides: 1)_____ 2)____ 3)____ 4)____
		Transport Index: _____
		11. Verify the information for this shipment is specified in the MURR Irradiation/Shipment request form and is within the license restrictions.
	_____	a. License number, amendment number and expiration date agree.
	_____	b. Verify that activity has been approved as per Precautions and Limitations of MURR-SAS-00004 (2.12).
	_____	c. Isotope and activity is within acceptable limits and possession limits.
	_____	d. The shipping address is correct.
	_____	12. Transfer Form is in packing enclosure.

Note: ***Performer is to list information from each label. (The performer should not be the shippe releasing the container.)***

Inspector	Performer		
_____	_____	13.	Primary hazard labels verified and in place on opposite sides of the 7A container.
			Category: _____ _____
			Isotope(s): _____ _____
			Activity: _____ _____
			TI: _____ _____
_____	_____	14.	Verify appropriate subsidiary risk and handling label(s) are adjacent to the primary hazard labels (List). (Include "RQ" before or after if applicable)
			_____ _____ _____
_____	_____	15.	Shipment Waybill(s), address label and 7A container preprinted identification label agree.
	_____	16.	Sodium Iodide Spectrum completed.
	_____	17.	Consignee notified of shipment.

Shipment approved for release by:

_____
Certified Shipper's Signature/Date

☐ This package is a category Yellow III, and requires vehicle placards.

I accept this shipment and certify that I have been offered radioactive placards, for Yellow III only, at the time it was offered for transport.

_____
Courier's Signature/Date

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT
1 January 1994 through 31 December 1994

HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

Original Hazards Summary Report, page 1-3, Section 1.1.3, paragraph 8; 1981-82 Annual Report revision:

Delete: "(4) 4 pneumatic tube irradiation positions."

Replace with: "(4) Pneumatic tube irradiation positions."

Original Hazards Summary Report, page 1-11, Section 1.4.3, paragraph 2, last sentence:

Delete: "In final form two parallel electrically controlled, nitrogen operated valves have replaced the vacuum breaker valve."

Replace with: "In final form two parallel electrically controlled, air operated valves have replaced the vacuum breaker valve."

Original Hazards Summary Report, page 5-2, Section 5.2.1, paragraph 1, sentence 1:

Delete "100 KW"; replace with "50 kW"

Original Hazards Summary Report, page 5-3, Section 5.2.2, paragraph 3, line 2:

Delete: "Water is automatically discharged into the hot waste system when the pressurizer level becomes too high."

Replace with: "Water is automatically discharged into the drain collection tank when the pressurizer level becomes too high."

Original Hazards Summary Report, page 5-8, Section 5.4.1, paragraph 2:

Delete: "Components comprising the secondary cooling system include: the pool heat exchanger, the primary heat and temperature instrumentation, radiation monitoring instrumentation, chemical addition equipment, primary and pool automatic control valves, ..."

Replace with: "Components comprising the secondary cooling system include: the pool heat exchanger, the primary heat exchanger and temperature instrumentation, radiation monitoring instrumentation, chemical addition equipment, primary and pool heat exchanger automatic control valves, ..."

Original Hazards Summary Report, page 5-9, Section 5.4.3, paragraph 2, sentence 2:

Delete: ". . . on the perimeter of the basin wall."

Original Hazards Summary Report, page 5-9, Section 5.4.4, sentence 3:

Delete: "One standby pump in addition to the number required for normal cooling is installed and operable."

Replace with: "One standby pump in addition to the number required for normal cooling is installed."

Original Hazards Summary Report, page 5-10, Section 5.4.5, paragraph 2, sentence 1:

Delete: "A complete system to measure gross gamma activity of the secondary system is installed with the output displayed and recorded in the reactor control room."

Replace with: "A complete system to measure gross gamma activity of the secondary system is installed with the output displayed in the reactor control room."

Original Hazards Summary Report, Figure 5.1:

Delete Figure 5.1; replace with updated Figure 5.1.

Original Hazards Summary Report, page 10-1, paragraph 1:

Delete: "Maintenance on the reactor and systems will normally be performed by personnel permanently assigned to the Research Reactor Facility for this purpose. The number of persons will be dependent upon work load. There will be at least one mechanical and one electrical technician permanently assigned at the facility. These people will receive training on the reactor and systems equivalent to that of a reactor operator and may become licensed reactor operators. They will be thoroughly indoctrinated with appropriate radiation health and safety practices."

Replace with: "Maintenance on the reactor and process systems will normally be performed by personnel permanently assigned to the Research Reactor Facility for this purpose. There will be at least one mechanical and one electrical technician permanently assigned at the facility. These people will receive training on the reactor and process systems similar to that of a reactor operator. They will be thoroughly indoctrinated with appropriate radiation health and safety practices."

1981-82 Annual Report Revision to the Original Hazards Summary Report, pages 10-1 - 10-2, Section 10.1, paragraph 1:

Delete: "The facilities provided at the Research Reactor Facility for performing maintenance tasks include:

(1) One 15 ton overhead crane in the reactor containment vessel.
[ ] rev. 1982
(5) A mechanical maintenance shop on grade level of the laboratory.
(6) An electrical and instrument maintenance shop on grade level of the laboratory.

The two shops (items 5 and 6 above) are equipped with the machine tools, small tools, electrical and instrument equipment necessary to perform the normal maintenance tasks required by the laboratory and the reactor."

Replace with: "The facilities provided at the Research Reactor Facility for performing maintenance tasks include:

(1) One 15 ton overhead rectilinear crane and one 500 lb. jib crane in the reactor containment building.
(2) A mechanical maintenance shop within the site boundary.
(3) An electrical and instrument shop within the site boundary.

The two shops (items 2 and 3 above) are equipped with the machine tools, small tools, electrical and instrument equipment necessary to perform the normal maintenance tasks required by the Research Reactor Facility."

Original Hazards Summary Report, page 10-2, Section 10.2, paragraph 1:

Delete: "Subsequent to reactor operation and prior to entry into contaminable areas a complete radiation survey will be made to establish dose rates. Also, following any change of conditions in which the dose rates may be effected, such as a change in pool water level, a survey will be made to ensure acceptable exposure rates."

Related with: "Subsequent to reactor operation and prior to entry into potentially contaminated areas, a complete radiation survey will be made to establish dose rates. Also, following any change of conditions in which the dose rates may be effected, such as a change in pool water level, a survey will be conducted to ensure dose rates are within acceptable limits."

Original Hazards Summary Report, pages 10-3 and 10-4, Section 10.2, paragraphs 5 & 6:

Delete: "To prevent endangering personnel during maintenance activities on electrical equipment a tag out procedure will be utilized on the electrical control to the associated equipment and, where possible, electrical breakers will be de-energized and tagged. (Refer to Section 10.7 for tag procedure).

Maintenance tasks other than routine (i.e., removal of graphite reflector, etc.) will be performed in accordance with special written procedures establishing condition of reactor, special tools required, monitoring requirements, personnel protection, and a detailed procedure. These special procedures will be reviewed and approved by the reactor supervisor."

Replace with: "To prevent endangering personnel during maintenance activities, a tag out system will be utilized. (Refer to Section 10.7 for tag procedure).

Non-routine maintenance tasks (i.e., removal of graphite reflector, etc.) will be performed in accordance with special written procedures. These special procedures will establish the condition of the reactor, include special tools required, describe the monitoring and personnel protection requirements, and include a step by step guide for completion of the maintenance activity. These special procedures will be reviewed and approved by the Reactor Manager."

Original Hazards Summary Report, page 10-4, Section 10.3, paragraph 2, sentence 5:

Delete: "Point of control will be at the entries as shown on Figure 3.2."

Replace with: "Point of control will be at the entries designated by Health Physics."

Original Hazards Summary Report, page 10-5, Section 10.3, paragraph 3, sentence 2:

Delete: "In the event that the maintenance activity may create air-borne activity continuous air samples will be taken and, if necessary or as a precautionary measure, proper respiratory protection will be provided."

Replace with: "In the event that the maintenance operation may create air-borne activity, continuous air monitoring capability, as necessary, will be prescribed by Health Physics."

1981-82 Annual Report Revision to Original Hazards Summary Report, page 10-5, Section 10.3, paragraph 6, sentence 2 through end of paragraph:

Delete: "Regeneration of the demineralizers is accomplished as described in Section 7.1.9 in areas shielded from the demineralizers. At intervals of approximately 18 to 24 months the resins will require changing. They will be discharged remotely into shielded containers and discarded as radioactive waste. [ ] (rev 1982). Constant health physics monitoring will be provided to personnel during the resin transfer procedure. Personnel will be provided proper protective clothing when necessary."

Replace with: "Regeneration or replacement of the demineralizer resin is accomplished as described in Section 7.1.9 in areas shielded from the demineralizers. At intervals of approximately two to four months the resins will require changing. They will be discharged into containers and discarded as radioactive waste. Monitoring, as prescribed by Health Physics, will be provided to personnel during the resin transfer procedure. Personnel will be provided proper protective clothing as necessary."

Original Hazards Summary Report, page 10-6, Section 10.4, paragraph 1, sentence 3 & 4:

Delete: "Protective clothing and respiratory protection will be provided when handling the contaminated filters. Immediately following removal of the filter from the system it will be placed in a plastic bag or other suitable air tight container and sealed."

Replace with: "Protective clothing will be prescribed by Health Physics when handling contaminated filters. Immediately following removal of a filter from the system it will be placed in a plastic bag or other suitable air tight container and sealed."

Original Hazards Summary Report, page 10-6, Section 10.5, paragraph 1, sentence 1:

Delete: "A periodic maintenance system will be in effect on all reactor, process and laboratory equipment."

Replace with: "A periodic maintenance system will be in effect on all reactor and process equipment."

Original Hazards Summary Report, page 10-6, Section 10.5, paragraph 1, sentence 3:

Delete: "A card file will be maintained providing the date and nature of maintenance activities on all equipment."

Replace with: "A record will be maintained providing the date and nature of maintenance activities on all equipment."

Original Hazards Summary Report, page 10-7, Section 10.5, paragraph 3:

Delete: "Acid resistant protective clothing and face shield will be worn by personnel performing work on the acid and caustic system, and an eye wash and shower is provided in the cooling tower building for use in the event of an emergency."

Replace with: "Acid resistant protective clothing and face shield will be worn by personnel performing work on the acid system. An eye wash and shower are provided in the cooling tower building for use in the event of an emergency."

Original Hazards Summary Report, page 10-7, Section 10.6, paragraph 3:

Delete: "A source check of the radiation monitoring system will be performed once every week to ensure proper operation. The calibration of instrumentation will be included in the maintenance program."

Replace with: "A source check of the radiation monitoring modules which are connected to the Safety System will be performed at least once per week to ensure proper operation. A source check of all the radiation monitoring modules will be performed quarterly to ensure proper operation. The calibration of instruments will be included in the maintenance program."

Original Hazards Summary Report, page 10-8, Section 10.7, number (1), sentence 2:

Delete: ". . . contain information as to the time it was initiated . . . ."

Replace with: ". . . contain information as to the date it was initiated . . . ."

Original Hazards Summary Report, page 10-8, Section 10.7, number (2), sentence 2:

Delete: ". . . contain information as to the time it was initiated . . . ."

Replace with: ". . . contain information as to the date it was initiated . . . ."

Original Hazards Summary Report, page 10-8, Section 10.7, number (3):

Delete: "A log book will be maintained containing the tag number, the time initiated, the equipment involved, the time of tag removal, and operator initials."

Repalce with: "A log book will be maintained containing the tag number, the date initiated, the equipment involved, the date of the tag removal, and the initials of the person responsible for tag placement and removal."

Original Hazards Summary Report, page 10-9, Figure 10.1:

Delete Figure 10.1; replace with updated Figure 10.1, Main Reactor Equipment Room.

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

Hazards Summary Report, Addendum 3, page 8, Section 2.1.2.12, sentence 1 and 2:

Delete: ". . . of the lock shield type with key. The locked shield is a cap which fits over the operator to prevent inadvertent operation of the valve."

Hazards Summary Report, Addendum 3, pages 9-10, Section 2.1.3.1:

Delete the phrase "pressure differential switch(es)"; replace with the phrase "differential pressure sensor(s)" throughout the section.

Hazards Summary Report, Addendum 3, page 10, Section 2.1.3.1, paragraph 2:

Delete "DPS 949"; replace with "DPS 929"

Hazards Summary Report, Addendum 3, page 18, Section 2.3.2.2, sentence 1:

Delete: "Cooling tower cell is a double flow . . . ."

Replace with: "Cooling tower cell #3 is a double flow . . . ."

Hazards Summary Report, Addendum 3, page 20, Figure 2.2:

Delete Figure 2.2; replace with updated Figure 2.2

HSR, Addendum 3, page 195, Section 5.4.2:

Add: "(October 1966 to July 1971)" after the section title.

HSR, Addendum 3, page 195, Section 5.4.2., paragraph 2:

Delete: "The reactor has operated at 5 MW from June 30, 1967, to the present. This power level was maintained for approximately 40 hours per week during the period of time from July 30, 1967, to September 29, 1969, and approximately 100 hours per week for the period from September 29, 1969, to the present."

Replace with: "The reactor was operated at 5 MW from June 1967 to May 1974. This power level was maintained for approximately 40 hours per week during the period of time from July 1967 to September 1969, and approximately 100 hours per week for the period from September 1969 to May 1974."

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

Hazards Summary Report, Addendum 4, page B-11, Section B.3, paragraph 2, line 5:

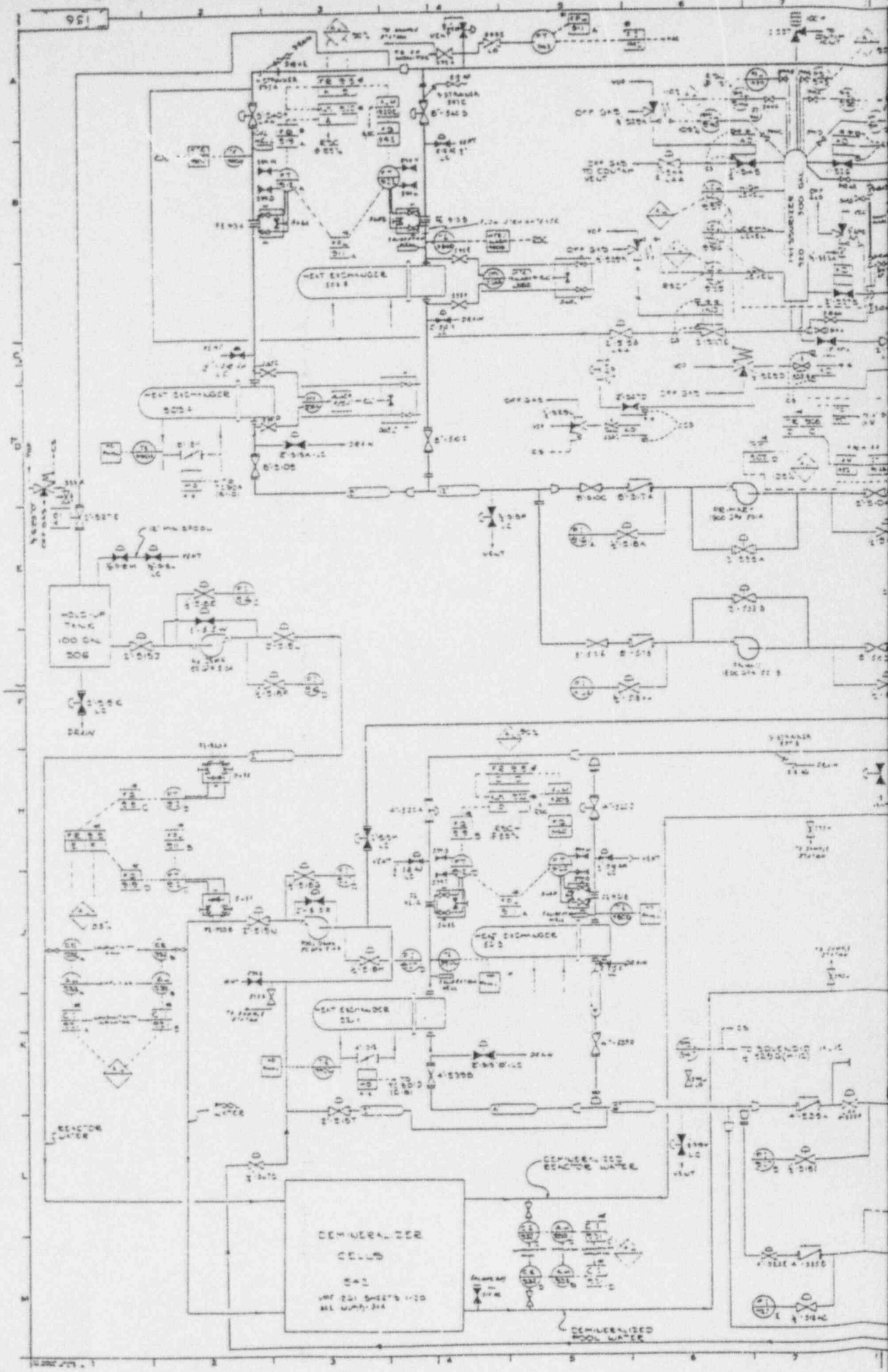
Delete: "The vent line from the existing vent tank will be extended and discharge into the gas retention tank."

Replace with: "The vent line from the existing vent tank will be extended and discharge through filters to the containment exhaust system."

Hazards Summary Report, Addendum 4, page D-3, Appendix D, Figure D.1:

Add the word "SIMPLIFIED" to beginning of title to read, "SIMPLIFIED SCHEMATIC DIAGRAM OF THE MURR PRIMARY COOLANT SYSTEM"

Add the following note under title: "(NOTE: This schematic does not include system changes made since 1974.)"


HEAT EXCHANGER
HEAT EXCHANGER
HEAT EXCHANGER
DRAIN
DEMINERALIZER
CELLS
DEMINERALIZED REACTOR WATER
DEMINERALIZED REACTOR WATER
DEMINERALIZED WATER

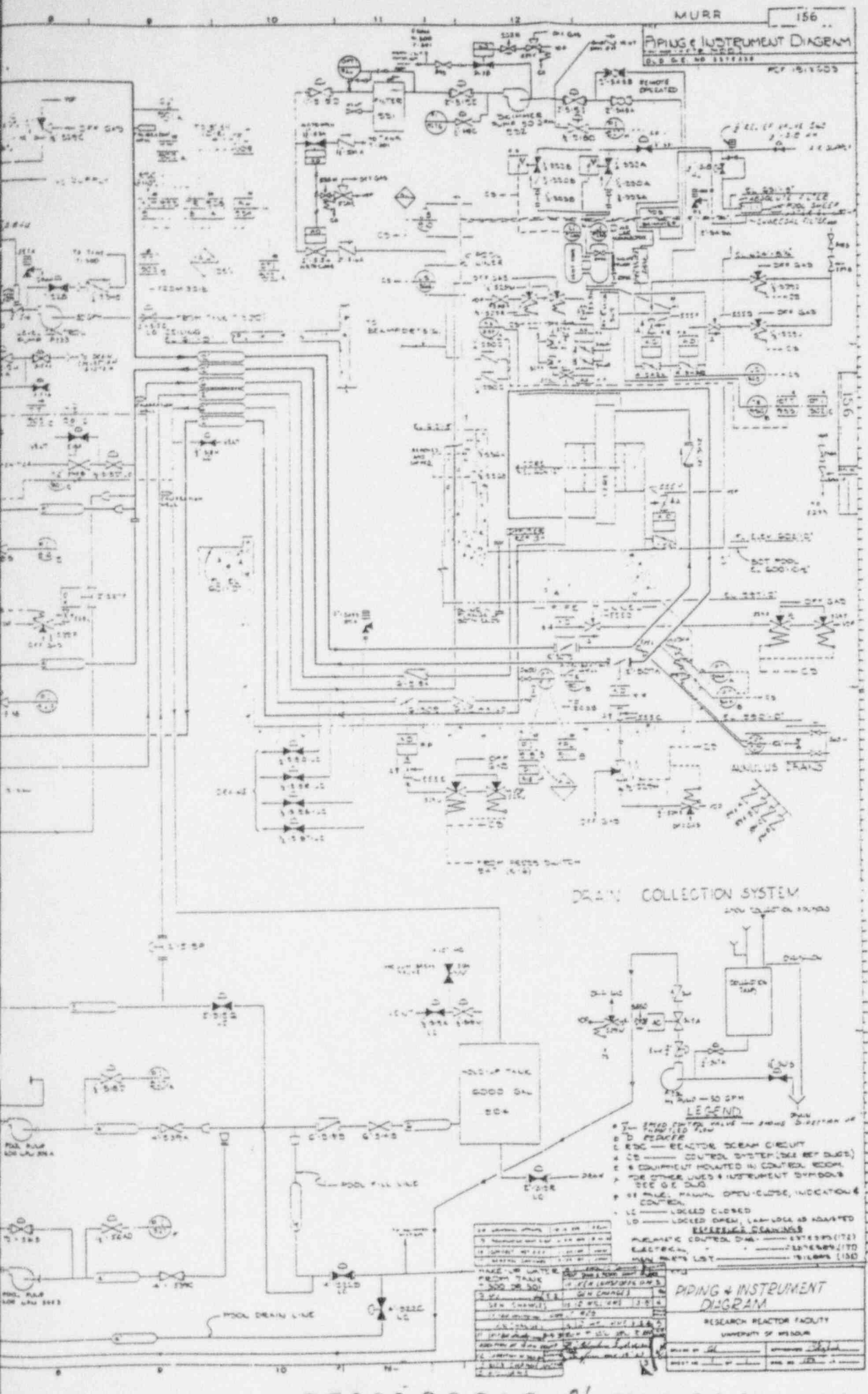


Figure 5.1 (Updated drawing)

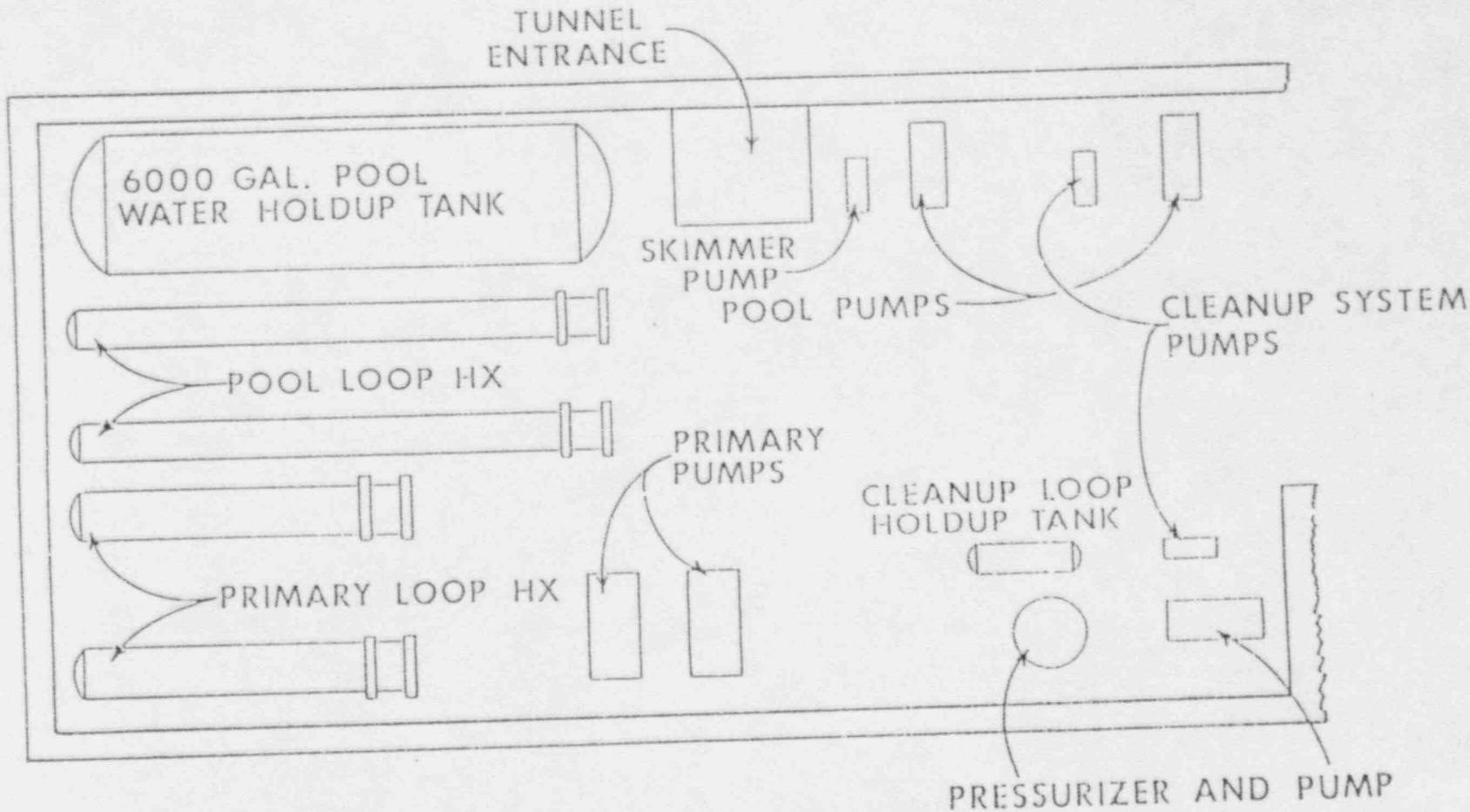


Figure 10.1 Main Reactor Equipment Room

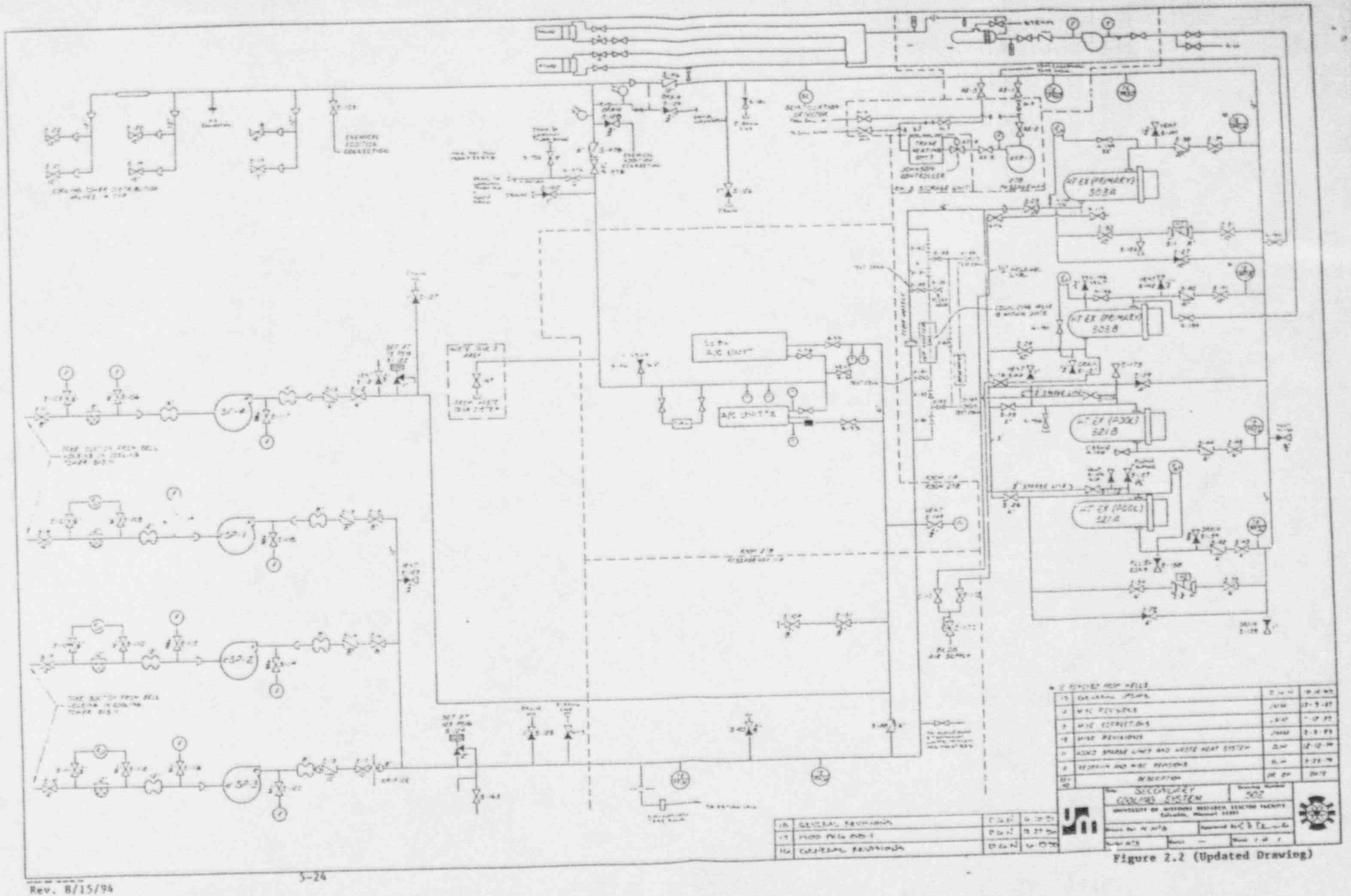


Figure 2.2 (Updated Drawing)

Rev. 8/15/94

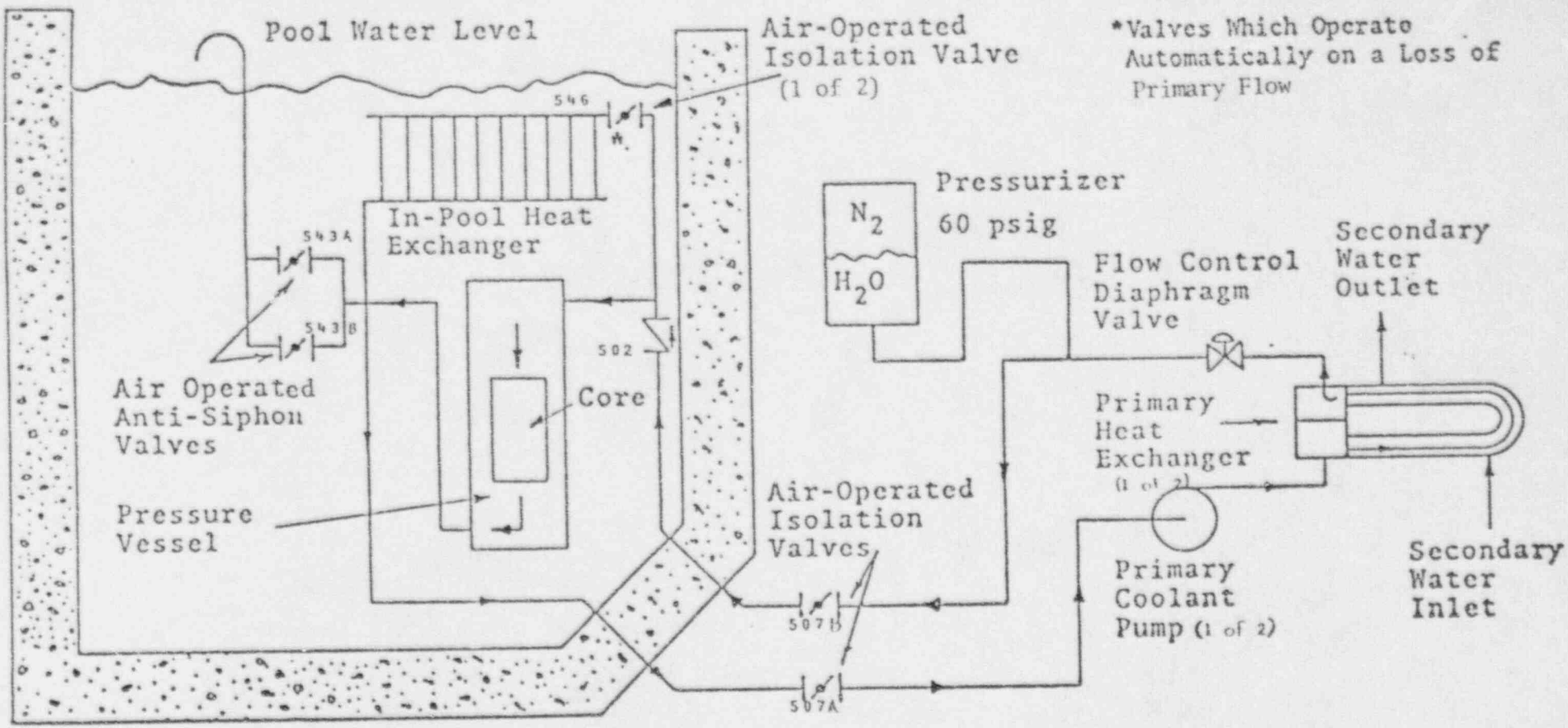


FIGURE D.1

SIMPLIFIED SCHEMATIC DIAGRAM OF THE MURR PRIMARY COOLANT SYSTEM

(NOTE: This schematic does not include system changes made since 1974.) **(rev 1994)**

SECTION IV

PLANT AND SYSTEM MODIFICATIONS
1 January 1994 through 31 December 1994

The safety evaluation for each modification described below is on file at MURR and documents that it does not present an unreviewed safety question as per 10 CFR 50.59.

Modification 93-2: Pneumatic tube air intake moved to air supply duct

This modification changed the location of the air supply for the pneumatic tube system from the basement to the ventilation system supply air mixing box for the basement. This modification also changed the supply HEPA filter from a 6 inch to a 12 x 12 x 12 inch HEPA. The exhaust filter housing was moved from the discharge side to the suction side of the blowers.

Modification 94-1: The elimination of experimental can in beamport experiments

This modification eliminated the experimental can from beamports "A", "B" and "C." This results in higher beam intensity for research. The beam tube can be flooded, drained, evacuated, or back filled with helium, the same as the previous mode with an experimental can.

Modification 94-2: Replacing graphite reflector elements 2 and 3, and replacing wedge "I" and "J" (silicon wedge)

This modification package documents the change of original graphite wedge 2 with 2A, and original graphite wedge 3 with 3B. Wedge 2A is virtually the same as wedge 2. Wedge 3B has two irradiation positions designed for pneumatic tube terminals. Both new wedges are made of the same material as the original wedges. Wedge "I" and "J" are aluminum wedges containing a void and self powered rhodium detectors. The new replacement wedge is the same as the one removed except for the addition of a small amount of graphite. The reactivity change was measured to be +0.0001 $\Delta k/k$.

Modification 94-3: Sampling and recording of reactor operating parameters for research into developing an "Expert System"

This modification package documented the connection of various reactor process variables to a computer based sampling and recording program to obtain data for an "Expert System." The necessary isolation devices were installed to ensure the data collection did not interfere with the process system or any safety related functions.

Modification 94-6: Costar tower constructed inside of the containment building

This modification package documented the addition of a five level steel storage structure on the west side of the containment building.

SECTION V

NEW TESTS AND EXPERIMENTS

1 January 1994 through 31 December 1994

New experimental programs during this period are as follows:

RUR-291, Zinc metal and zinc oxide; enriched Zn-64 or Zn-67:

Experimenter: S. Gunn

Description: This RUR authorized irradiation of zinc metal and oxide in a boron nitride shielded can for production of Cu-64 or Cu-67.

RUR-303, Zinc metal, natural abundance:

Experimenter: S. Gunn

Description: This RUR authorized irradiation of zinc metal for the production of Zn-65.

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 January 1994 through 31 December 1994

1. SNM Receipts: A total of 24 new fuel elements were received from Babcock and Wilcox (B & W), Lynchburg, Virginia.

Shipper	Elements	Grams U	Grams U-235
B & W	MO-401, MO-402, MO-403, MO-404, MO-405, MO-406, MO-407, MO-408, MO-409, MO-410, MO-411, MO-412, MO-413, MO-414, MO-415, MO-416, MO-417, MO-418, MO-419, MO-420, MO-421, MO-422, MO-423, MO-424	19,934	18,562

2. SNM Shipments: A total of 8 spent fuel elements were shipped to DOE facilities at Savannah River Plant, Aiken, South Carolina.

Shipper	Elements	Grams U	Grams U-235
MURR	MO-343, MO-344, MO-345, MO-346, MO-348, MO-350, MO-351, MO-353	5,397	4,709

3. Inspections: None.

4. SNM Inventory: As of 31 December 1994, MURR was financially responsible for the following DOE-owned amounts:

   Total U = 55,411 grams

   Total U-235 = 49,484 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 1994.

Burned-up Elements (32)

Element No.	MWD	Element No.	MWD	Element No.	MWD
MO-321	126.10	MO-360	135.08	MO-371	113.50
MO-322	126.10	MO-361	131.22	MO-372	134.27
MO-347	137.81	MO-362	131.58	MO-373	129.35
MO-349	137.81	MO-363	131.22	MO-374	132.31
MO-352	136.11	MO-364	131.58	MO-375	129.35
MO-354	136.11	MO-365	126.99	MO-376	132.31
MO-355	130.10	MO-366	129.14	MO-378	127.98
MO-356	130.10	MO-367	126.99	MO-380	127.98
MO-357	134.86	MO-368	129.14	MO-381	114.55
MO-358	134.86	MO-369	113.50	MO-383	114.55
MO-359	135.08	MO-370	134.27		

Elements in Service (44)

MO-377	98.59	MO-396	99.78	MO-411	77.75
MO-379	98.59	MO-397	90.36	MO-412	69.22
MO-382	99.44	MO-398	86.89	MO-413	69.16
MO-384	99.44	MO-399	90.36	MO-414	59.47
MO-385	99.46	MO-400	86.89	MO-415	69.16
MO-386	95.93	MO-401	85.00	MO-416	42.79
MO-387	99.46	MO-402	88.36	MO-417	59.47
MO-388	95.93	MO-403	85.00	MO-418	42.79
MO-389	99.31	MO-404	88.36	MO-419	28.60
MO-390	94.03	MO-405	86.41	MO-420	28.60
MO-391	99.31	MO-406	92.27	MO-421	10.32
MO-392	94.03	MO-407	86.41	MO-422	0.00
MO-393	94.97	MO-408	92.27	MO-423	10.32
MO-394	99.78	MO-409	77.75	MO-424	0.00
MO-395	94.97	MO-410	69.22		

Average Burn-up (all elements): 98.40 MWD

SECTION VII

REACTOR PHYSICS ACTIVITIES
1 January 1994 through 31 December 1994

1. Fuel Utilization: During the period 1 January 1994 through 31 December 1994, the following elements reached licensed or feasible burn-up and were retired:

Serial Number	Final Core	Date Last Used	MWD
MO-355	94-09	03-07-94	130.10
MO-356	94-09	03-07-94	130.10
MO-357	94-35	08-08-94	134.86
MO-358	94-35	08-08-94	134.86
MO-361	94-12	03-21-94	131.22
MO-362	94-22	05-23-94	131.58
MO-363	94-12	03-21-94	131.22
MO-364	94-22	05-23-94	131.58
MO-365	94-17	04-18-94	126.99
MO-366	94-03	01-24-94	129.14
MO-367	94-17	04-18-94	126.99
MO-368	94-03	01-24-94	129.14
MO-369	94-54	12-08-94	113.50
MO-370	94-23	05-31-94	134.27
MO-371	94-54	12-08-94	113.50
MO-372	94-23	05-31-94	134.27
MO-373	94-45	10-10-94	129.35
MO-374	94-26	06-20-94	132.31
MO-375	94-45	10-10-94	129.35
MO-376	94-26	06-20-94	132.31
MO-378	94-52	11-28-94	127.98
MO-380	94-52	11-28-94	127.98
MO-381	94-56	12-19-94	114.55
MO-383	94-56	12-19-94	114.55

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 1994. 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.

Serial Number	Fabrication Core Number	Initial Core Load Number	Initial Operating Date
MO-394	65	94-3	01-18-94
MO-396	65	94-3	01-18-94
MO-397	65	94-5	01-31-94
MO-398	65	94-5	01-31-94
MO-399	66	94-5	01-31-94
MO-400	66	94-5	01-31-94
MO-401	66	94-12	03-14-94
MO-402	66	94-16	04-04-94
MO-403	66	94-12	03-14-94
MO-404	66	94-16	04-04-94
MO-405	66	94-20	05-02-94
MO-406	66	94-20	05-02-94
MO-407	67	94-20	05-02-94
MO-408	67	94-20	05-02-94
MO-409	67	94-30	07-05-94
MO-410	67	94-35	08-01-94
MO-411	67	94-30	07-05-94
MO-412	67	94-35	08-01-94
MO-413	67	94-38	08-22-94
MO-414	67	94-45	10-03-94
MO-415	68	94-38	08-22-94
MO-416	68	94-48	10-24-94
MO-417	68	94-45	10-03-94
MO-418	68	94-48	10-24-94
MO-419	68	94-52	11-21-94
MO-420	68	94-52	11-21-94
MO-421	68	94-57	12-20-94
MO-423	69	94-57	12-20-94

2. Fuel Shipments: Eight spent fuel elements were shipped from MURR to Savannah River Plant, Aiken, South Carolina. The identification numbers of these elements are:

MO-343	MO-345	MO-348	MO-351
MO-344	MO-346	MO-350	MO-353

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 1994, 225 fuel assemblies fabricated by B & W had been received and 223 used in cores at 10 MW.

4. Licensing Activities: On August 5, 1994, the Nuclear Regulatory Commission approved Amendment No. 26 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. Eight spent fuel elements were shipped in the period of this report. Three shipments are scheduled in 1995, but late enough in the year that the 60 kg limit will be exceeded in June 1995. Early in February 1995, MURR will submit a request for a temporary increase of the possession limit to 75 kg until May 31, 1997. This will ensure that MURR can continue normal operation into early 1997 even though we may not be allowed to ship spent fuel in 1996. If spent fuel shipments are not made in 1996, the 75 kg temporary possession limit will be reached in February 1997.

   MURR staff have continued their efforts to achieve more regular acceptance of spent fuel at Savannah River Plant with limited success. The Department of Energy has had to juggle the spent fuel needs of university research reactors and DOE reactors, with the receipt and storage of foreign fuel. This has lead to uncertainty and numerous changes to our spent fuel shipping opportunities.

   A request for a unique purpose exemption as defined in 10 CFR 50.2 was submitted September 26, 1986, and is pending.

5. Reactor Characteristic Measurements: Fifty-nine refueling evolutions were completed. An excess reactivity verification was performed for each refueling and the average excess reactivity was 1.86%. The largest excess reactivity was 2.79%. MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

   Reactivity measurements were performed for ten evolutions to verify reactivity parameters for the flux trap. Four differential worth measurements were made on shim blades. Two measurements were made when graphite reflector wedges were changed. One measurement of a temperature coefficient was made.

SECTION VIII

SUMMARY OF RADIOACTIVE EFFLUENT RELEASED TO THE ENVIRONMENT

Sanitary Sewer Effluent
1 January 1994 through 31 December 1994

Descending Order of Activity Released for Isotope Totals > 1.00E-5 Ci:

Nuclide	Amount (Ci)
H-3	1.089E-01
S-35	1.117E-02
Ca-45	3.794E-03
Co-60	1.496E-03
As-77	1.411E-03
Re-186	3.193E-04
Zn-65	1.118E-04
Se-75	6.626E-05
Cr-51	4.781E-05
Eu-152	2.533E-05
Gd-159	1.686E-05
Sb-124	1.632E-05
Ta-183	1.555E-05
Total H-3	1.089E-01 Ci
Total Other	1.849E-02 Ci

Stack Effluent
1 January 1994 through 31 December 1994

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration (µCi/ml)	Total Release 1/94 - 12/94 (Ci)	TS Limit Multiplier	% TS*
Ar-41	7.44E-07	3.7E+02	350	21.2578
Cd-109	2.14E-13	1.1E-04	1	0.3062
I-131	6.09E-13	3.0E-04	1	0.3045
H-3	3.10E-08	1.5E+01	350	0.0886
Pd-103	2.59E-12	1.3E-03	1	0.0519
Co-60	1.73E-14	8.6E-06	1	0.0346
Sb-76	1.35E-13	6.7E-05	1	0.0169
Ce-144	2.33E-15	1.2E-06	1	0.0116
Te-125M	8.31E-14	4.1E-05	1	0.0083
K-40	4.46E-14	2.2E-05	1	0.0074
W-188	1.30E-13	6.4E-05	1	0.0065
Hg-203	2.90E-14	1.4E-05	1	0.0029
Cs-137	5.32E-15	2.6E-06	1	0.0027
Eu-155	5.24E-15	2.6E-06	1	0.0026
Zn-65	6.23E-15	3.1E-06	1	0.0016
I-133	5.18E-12	2.6E-03	350	0.0015
Rb-86	1.27E-14	6.3E-06	1	0.0013
Tm-170	3.35E-15	1.7E-06	1	0.0011
Sn-113	7.01E-15	3.5E-06	1	0.0009
Pa-233	5.52E-15	2.7E-06	1	0.0007
Ce-139	5.32E-15	2.6E-06	1	0.0006
I-135	1.18E-11	5.8E-03	350	0.0006
Sc-46	1.30E-15	6.4E-07	1	0.0004
As-77	9.51E-12	4.7E-03	350	0.0004
Os-191	7.62E-15	3.8E-06	1	0.0004
Ir-192	1.14E-15	5.7E-07	1	0.0004
I-134	4.05E-11	2.0E-02	350	0.0002
Co-57	1.52E-15	7.5E-07	1	0.0002
I-132	1.10E-11	5.5E-03	350	0.0002
Re-188	1.63E-12	8.1E-04	350	0.0001
Ce-141	7.74E-16	3.8E-07	1	0.0001
Xe-135M	1.19E-11	5.9E-03	350	0.0001
Pd-109	1.63E-12	8.1E-04	350	0.0001
Cd-115	1.35E-15	6.7E-07	1	0.0001
Ba-140	1.21E-15	6.0E-07	1	0.0001
Mn-54	5.60E-16	2.8E-07	1	0.0001
Total				22.1134

* Isotopes observed at <0.0001% TS limit are not listed.

Stack flow rate 33,500 cfm.

SECTION IX

SUMMARY OF ENVIRONMENTAL SURVEYS
1 January 1994 through 31 December 1994

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 April 1994.

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.8 pCi/l	2.7 pCi/l	245.8 pCi/l	22.8 pCi/ml of sample
Soil	0.8 pCi/g	2.7 pCi/g	0.3 pCi/g	N/A
Vegetation	1.6 pCi/g	5.4 pCi/g	1.0 pCi/g	22.8 pCi/ml 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

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
1V45	< 1.6	27.9	< 1.0	< 22.8
2V45	< 1.6	22.2	< 1.0	< 22.8
3V45	< 1.6	21.8	< 1.0	< 22.8
4V45	< 1.6	23.7	1.0	< 22.8
5V45	< 1.6	19.2	1.4	< 22.8
6V45	< 1.6	26.7	1.5	< 22.8
7V45	< 1.6	19.4	< 1.0	< 22.8
10V45	< 1.6	16.8	< 1.0	< 22.8

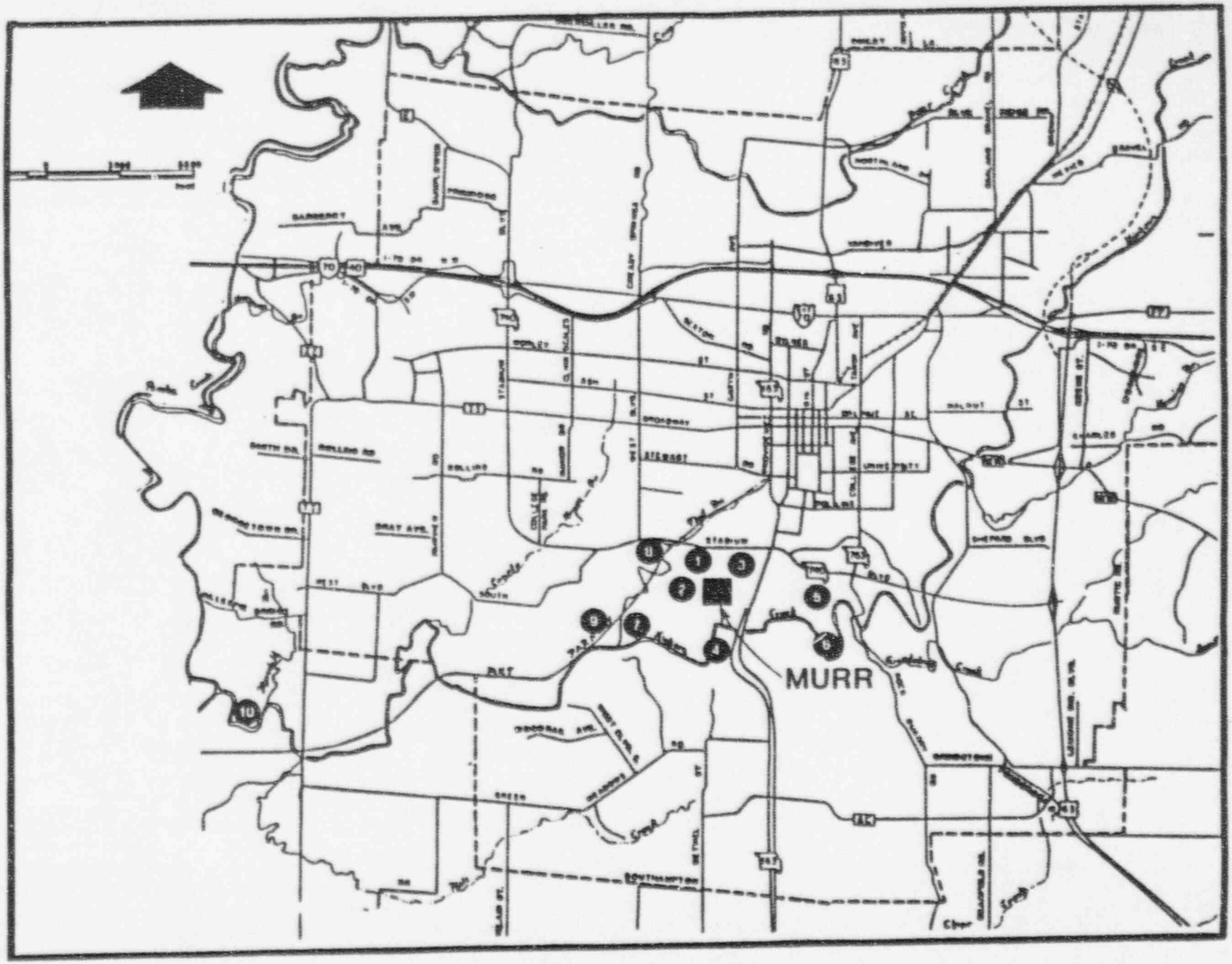


Figure 1. MURR Environmental Program Sample Stations

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

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S45	1.0	16.3	4.5
2S45	< 0.8	12.4	6.1
3S45	0.8	10.9	5.8
4S45	0.8	9.6	4.8
5S45	0.8	14.3	6.6
6S45	< 0.8	7.8	6.2
7S45	1.2	13.9	7.0
10S45	0.8	15.2	5.8

Determined Radioactivity Levels -- Water Samples

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
4W45	< 0.8	10.9	< 245.8	< 22.8
6W45	1.7	10.7	< 245.8	< 22.8
10W45	< 0.8	4.7	< 245.8	< 22.8

2. Sampled October 1994.

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.64 pCi/l	2.19 pCi/l	214.99 pCi/l	12.26 pCi/ml of sample
Soil	0.63 pCi/g	2.17 pCi/g	0.33 pCi/g	N/A
Vegetation	1.23 pCi/g	4.22 pCi/g	0.79 pCi/g	12.26 pCi/ml of distillate

* Gamma and tritium analyses are based on wet weights while alpha and beta are based on dry weights.

Determined Radioactivity Levels -- Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
1V46	< 1.23	15.01	< 0.79	< 12.26
2V46	< 1.23	18.95	< 0.79	< 12.26
3V46	< 1.23	8.95	1.04	< 12.26
4V46	< 1.23	20.75	0.97	< 12.26
5V46	< 1.23	15.57	< 0.79	< 12.26
6V46	< 1.23	36.07	< 0.79	< 12.26
7V46	< 1.23	18.41	1.23	< 12.26
10V46	< 1.23	17.97	< 0.79	< 12.26

Determined Radioactivity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1S46	< 0.63	12.25	6.63
2S46	0.99	16.65	7.56
3S46	0.83	11.64	6.77
4S46	< 0.63	7.43	3.80
5S46	1.31	14.11	7.36
6S46	< 0.63	10.04	6.76
7S46	0.82	12.33	6.73
10S46	0.66	11.55	8.24

Determined Radioactivity Levels -- Water

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
4W46	2.05	19.01	< 214.99	< 12.26
6W46	< 0.64	12.86	< 214.99	< 12.26
10W46	< 0.64	16.29	< 214.99	< 12.26

ENVIRONMENTAL TLDs

The table on the following page lists the external radiation doses recorded by monitors deployed around MURR in 1994. All doses are about 50 mrem/year or less, except monitor number 9. This monitor is located above the loading dock where packages containing radioactive material are loaded on transport vehicles and the monitor location is shielded from activities in MURR by two feet of concrete. The dose recorded by this monitor is considered to be the result of exposure to packages in transit. To help validate this conclusion, the third and fourth quarter of 1994 monitors numbered 1, 2, and 3 were located in the loading dock area. The monitors were positioned so that they were shielded from packages in transit, but not shielded from activities in the building. The results of these measurements support the previous evaluation. Doses recorded by monitors located on the brick exterior of the building have been corrected to account for the natural radiation emitted from the bricks. Tests indicate that contact with the type of brick used in this facility will add 15 to 20 mrem/quarter to the dose results.

Environmental TLD Summary
January through December 1994

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 1994 Net mR	2nd Qtr. 1994 Net mR	3rd Qtr. 1994 Net mR	4th Qtr. 1994 Net mR	Total 1994 Net mR
1	S	27	0.6	0.9	2.5	4.3	8.3
2	S	27	0.6	0.3	7.5	9.5	17.9
3	S	27	-0.3	0.0	0.0	9.8	9.5
4	S	70	0.9	2.3	0.0	13.1	16.3
5	Control	N/A	-0.7	2.6	1.7	1.4	5.0
6	NNE	34	9.1	10.4	14.7	15.5	49.7
7	ESE	57	9.7	13.2	13.2	14.5	50.6
8	WSW	27	11.5	10.8	13.8	13.3	49.4
9	SSE	27	46.0	65.4	59.4	65.8	236.6
10	NE	149	6.1	0.4	2.5	2.0	11.0
11	N	149	1.5	5.3	6.4	6.0	19.2
12	ENE	301	5.1	9.2	7.9	8.1	30.3
13	NNE	316	6.6	6.3	6.2	6.0	25.1
14	S	156	5.2	9.1	8.6	lost	22.9
15	S	65	2.4	4.1	5.7	12.3	24.5
16	SE	107	3.4	6.1	5.4	5.5	20.4
17	E	293	2.8	4.0	lost	6.8	13.6
18	NE	476	3.8	5.6	-19.9	7.2	-3.3
19	NNE	606	2.8	5.0	5.9	9.4	23.1
20	NE	907	2.5	5.4	4.9	5.2	18.0
21	SE	236	1.8	4.9	6.1	6.2	19.0
22	ESE	168	-0.8	4.3	-1.0	1.6	4.1
23	NW	110	1.5	7.7	4.0	4.4	17.6
24	SSW	328	2.3	1.5	4.4	4.1	12.3
25	SSW	480	3.3	6.0	5.4	8.5	23.2
26	SW	301	3.6	5.8	6.9	7.4	23.7
27	WSW	141	-1.4	-0.8	0.7	1.5	0.0
28	WNW	210	4.0	6.9	5.5	7.3	23.7
29	NW	255	4.4	2.2	6.8	5.6	19.0
30	NNW	328	2.3	5.4	4.4	5.1	17.2
31	NNE	671	5.8	4.4	4.7	6.0	20.9
32	NNW	724	4.9	6.4	6.1	7.5	24.9
33	E	671	-0.4	3.1	1.5	2.6	6.8
34	ENE	587	1.6	2.7	2.9	-0.9	6.3
35	SSE	499	4.4	6.7	6.3	7.1	24.5
36	SE	419	5.0	5.5	5.5	4.7	20.7
37	NE	690	0.7	-0.3	-0.6	1.6	1.4
38	NW	556	4.7	7.1	7.3	5.3	24.4
39	W	491	3.9	5.5	7.2	8.5	25.1
40	N	514	3.5	5.5	6.8	5.9	21.7
41	ENE	137	5.3	6.8	8.9	5.6	26.6
42	In Building	N/A	8.4	11.4	11.4	12.7	43.9
43	In Building	N/A	8.2	11.3	7.3	7.2	34.0
44	Distant Site	N/A	-1.5	0.7	2.3	3.2	4.7
45	S	70	6.2	6.6	6.3	8.6	27.7

NUMBER OF FACILITY RADIATION AND CONTAMINATION SURVEYS

1994	Radiation	Surface Contamination*	Air Samples	RWP
January	16	26	16	11
February	52	50	15	10
March	63	57	15	6
April	48	38	18	10
May	55	48	13	9
June	62	56	15	8
July	41	41	15	5
August	54	42	16	13
September	57	52	19	7
October	94	83	19	5
November	41	39	16	5
December	25	30	19	6
TOTALS	608	562	196	95

*Note: In addition, general building contamination surveys are conducted each normal work day.

Miscellaneous Items

In March 1994 Dr. Susan M. Langhorst, Manager, Reactor Health Physics, returned to the University from sabbatical in Washington, DC. Upon her return she immediately accepted an interim assignment as the Radiation Safety Officer responsible for the Columbia Campus, Broad Scope Materials License. Mr. John Ernst continues to serve as Acting Health Physics Manager in her absence. August 1, 1994, Ray W. Stevens resigned from his position as Senior Health Physics Technician. Ray had been a member of the Health Physics Group for over eleven years. In December 1994, James R. Schuh, Health Physicist and Rex G. Ayers, Senior Health Physics Technician each received a Masters Degree in Nuclear Engineering/Health Physics. The current Health Physics staff is as follows: Acting Health Physics Manager, one Health Physicist, one Senior Health Physics Technician, three Health Physics Technicians, one Senior Secretary and two half time student assistants.

MURR shipped 660 cubic feet of LSA radioactive waste in the first half of 1994. On July 1, licensees in Missouri were denied access to the currently operating waste disposal sites. Radioactive waste produced at MURR will be stored for the foreseeable future.

The ALARA program was expanded to include the review of releases of radioactive material to the environment as well as occupational exposure. Releases to the sanitary sewer and from the facility ventilation system are reviewed monthly to ensure that they are not only within the regulations, but are also reasonable for the work performed. The average monthly whole body deep dose to individuals in each ALARA review group are shown in the following table:

Group Name	Average Monthly Dose
Actinide Chemistry	minimal
Computer Development	minimal
Electronic and Mechanical Properties	minimal
Director's Office	minimal
Facilities Operations	10 mrem
Gamma Ray Scattering	10 mrem
Health Physics	50 mrem
Instrument Development	minimal
Magnetic and Crystal Structure	10 mrem
Nanostructures and Excitations	10 mrem
Neutron Optics	20 mrem
Analytical Group	minimal
Nuclear Archaeology and Geochemistry	minimal
Nuclear Engineering	minimal
Operations	85 mrem
Radiopharmaceutical	minimal
Services Applications	25 mrem

SECTION X

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

1 January 1994 through 31 December 1994

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):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	137	150	154	137	160	147	163	134	159	154	166	160
A M E	70	64	59	75	59	67	54	75	51	59	49	46
A E	63	78	82	91	83	68	57	54	58	64	65	63
H E	210	200	700	310	330	210	230	190	170	230	180	160

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	54	63	68	65	64	67	68	58	67	64	67	59
A M E	7	7	2	2	5	2	1	4	1	5	3	5
A E	30	27	30	35	16	30	60	30	30	16	27	18
H E	70	50	40	50	40	50	60	80	30	30	40	30

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	162	140	157	149	163	154	174	129	152	145	141	138
A M E	83	104	88	90	78	77	67	91	79	68	76	70
A E	133	140	216	162	231	159	186	173	145	177	152	125
H E	500	690	1910	1040	3200	970	1430	1070	1020	820	710	690

Self Reading Dosimeters:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	18	22	16	22	7	13	8	12	5	22	19	4
A M E	103	107	104	99	121	97	103	96	104	88	74	91
A E	44	48	34	52	42	46	44	37	36	40	45	43
H E	183	180	190	318	342	230	224	215	202	177	154	186

SECTION X

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

1 January 1994 through 31 December 1994

SPARE ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	36	59	63	42	47	42	38	47	43	39	34	32
AME	8	4	3	3	6	8	5	6	3	2	1	4
AE	24	30	23	90	33	29	28	30	23	30	10	18
HE	50	60	40	160	50	60	70	60	50	50	10	30

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	32	43	60	57	53	51	54	48	40	33	34	40
AME	0	0	1	0	2	2	0	0	0	0	0	0
AE	0	0	100	0	15	10	0	0	0	0	0	0
HE	0	0	100	0	20	10	0	0	0	0	0	0

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ME	35	32	26	31	31	28	37	30	35	35	34	35
AME	3	6	9	7	7	9	1	7	3	3	4	3
AE	73	57	87	79	146	77	310	283	47	60	60	53
HE	100	80	160	140	350	200	310	1030	70	110	80	100