UNIVERSITY OF MISSOURI

Research Reactor Facility

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

Fax (314) 882-3443

August 29, 1990

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

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

SUBJECT: Anual Repcrt as required by Technical
Specification 6.1.h(4).

Dear Sir:

Enclosed are two copies of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers 1 July 1989 through 30 June 1990.

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

Sincerely,

Walt A. Meyer, Jr.
Reactor Manager

Enclosure (2)

xc w/report: U.S. N.R.C.
c/o Document Control Desk
Washington, DC

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UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

OPERATIONS ANNUAL REPORT

1989 - 1990

UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY
RESEARCH EDUCATION SERVICE

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UNIVERSITY OF MISSOURI
RESEARCH REACTOR

OPERATIONS ANNUAL REPORT

1989 - 1990

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS

ANNUAL REPORT

AUGUST 1990

Compiled by the Reactor Staff

Submitted by

Walt A. Meyer, Jr.
Reactor Manager

Reviewed and Approved

J. C. McKibben
Associate Director

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SECTION I

REACTOR OPERATIONS SUMMARY
1 July 1989 through 30 June 1990

The following table and discussion summarize reactor operations in the period 1 July 1989 through 30 June 1990.

Date	Full Power Hours	Megawatt Days	Full Power Percent of Total Time	Full Power Percent of Schedule*
July 1989	669.55	279.20	89.99	100.79
Aug. 1989	673.53	280.79	90.53	101.39
Sept. 1989	641.25	267.34	89.06	99.75
Oct. 1989	609.77	254.31	81.85	91.67
Nov. 1989	528.61	220.52	73.42	82.23
Dec. 1989	681.26	284.08	91.57	102.56
Jan. 1990	659.64	275.34	88.66	99.30
Feb. 1990	617.80	257.62	91.93	102.97
Mar. 1990	697.98	290.91	93.81	105.07
Apr. 1990	634.59	264.55	88.26	98.85
May 1990	689.04	287.21	92.61	103.73
June 1990	650.13	271.08	90.30	101.13
Total for Year	7753.15	3232.95	88.51% of Time for Yr. at 10MW	99.13% of Sched. Time for Yr. at 10 MW

*MURR is scheduled to average at least 150 hours per week at 10MW. Total time is the number of hours in a month or year.

During the months of October and November (October 29-November 6), the reactor was shut down for an extended period of time, 7.15 days, to replace the beryllium reflector. During the maintenance outage, four (4) graphite wedges were also replaced and various in-pool valves were rebuilt. The extended shutdown accounts for the low percentage of total operating time during these two months: 81.85% for October and 73.42% for November.

There were 30 unscheduled shutdowns recorded during the year 1 July 1989 through 30 June 1990. Only 8 were in the last six months, which

could be attributable to the UPS being installed in October 1989. Of these shutdowns, 10 were Rod Run-Ins (RRIs) and 20 were scrams.

Seven of the unscheduled shutdowns (2 RRIs and 5 scrams), were due to a Nuclear Instrument drawer, detector or detector cabling failure generating a spurious shut down signal (no actual high power or short period was indicated). A bid package is being prepared to upgrade this instrumentation and a request was made to DOE for money to support this upgrade. We anticipate that integrated cable detectors and new Nuclear Instrumentation will solve the spurious scram problems.

Of the remaining 23 unscheduled shutdowns, nine were component failures, six were due to loss of electrical power to the facility five were due to personnel errors, and three were initiated by the duty operator in order to repair equipment.

<u>July 1989</u>

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

On July 3, a reactor scram occurred while shifting the wide range switch upscale during a normal reactor startup. Electronics technicians used a current source to simulate input to the wide range monitor (nuclear instrument channel #4), but could not reproduce this problem. The cause was suspected to be a sticking relay contact in the feedback network of the picoammeter module for channel #4. The wide range switch was cycled through its full range and the picoammeter relays operated normally. A normal startup was completed with no further problems.

On July 4, a rod not in contact with magnet rod run-in occurred when control blade "C" disengaged from its magnet during routine shimming. The control blade drive mechanism was removed and the upper guide tube was realigned to center the anvil. The surface of the anvil was cleaned. A hot reactor startup was then completed with no further problems. On the next maintenance day, the offset mechanism and guide tube for control blade "C" was thoroughly inspected and further refinement of the alignment was accomplished. The control blade was then pull-tested satisfactorily.

On July 18, two reactor scrams occurred due to momentary site electrical power interruptions which occurred during a thunderstorm. These interruptions were verified by the power plant.

On July 28, the reactor was manually scrammed upon discovery of a leak from primary heat exchanger 503A. After noticing an unexplained decrease in the primary pressurizer water level, the duty shift supervisor immediately made a brief visual inspection of the mechanical equipment room and discovered water leaking from the end-cap flange of primary heat exchanger 503A. The control room operator was instructed to immediately scram the reactor. Coincident with the manual scram, the duty operator noted that a rod not in contact with magnet RRI was annunciated and that the natural convection cooling valves (546 A/B) were open. It is believed that an unannunciated Power Level Interlock scram from the core DP transmitter 929 occurred just shortly before the manual scram due to a pressure dip caused when the leakage from the heat exchanger increased. After the manual scram, a Power Level Interlock scram locked in on the annunciator which was initiated by core DP transmitter 929.

Subsequent investigation of the heat exchanger revealed a tear in the end-cap gasket. The flange surface was cleaned and the gasket was replaced. The reactor was then returned to normal operation.

On July 30, a reactor scram occurred due to a complete loss of site electrical power. The emergency generator started immediately and assumed its electrical load satisfactorily. The power loss was caused by a severe thunderstorm. Site power returned after approximately 45 minutes and the reactor was refueled and returned to normal operation.

Major maintenance for July included: installing a new bellows seal and bearings on pool demineralizer pump 513B; removing, taking measurements on, and reinstalling the Nuclepore irradiator case; and replacing the endcap gasket on primary heat exchanger 503A.

August 1989

The reactor operated continuously in August with the following exceptions: four shutdowns for scheduled maintenance and refueling; three unscheduled shutdowns; and one power reduction to examine the Beamport "F" valve arrangement.

On August 15, a rod not in contact with magnet rod run-in occurred when control blade "B" disengaged from its magnet during routine shimming. The drive housing for this control blade was removed, the magnet and anvil were inspected and the guide tube was realigned. Electronics technicians subsequently checked and verified the continuity of the drive mechanism amphenol connector. A hot reactor startup was completed and the reactor was returned to normal operation.

On August 22, a manual rod run-in was initiated to allow investigation of an observed water leak in the mechanical equipment room. The small leak was determined to be coming from a sensing line for primary flow element 912E. The reactor was subsequently manually scrammed to allow repair of this line. Machine Shop personnel removed a section of tubing where the leak occurred and placed a compression coupling in the sensing line to rejoin the sections. No more leakage was observed and the reactor was refueled and returned to normal operation. This entire sensing line was replaced on the next maintenance day.

On August 31, a reactor scram occurred from what was believed to be a spurious reactor loop low flow signal initiated by primary flow element 912E. The annunciation for this scram was reset before it was adequately documented by the duty operator, therefore the "white rat" scram monitor was used to help determine the most likely cause. It was determined from scram monitor indications that the most likely cause was a reactor loop low flow signal from primary flow element 912E.

One of the sensing lines for this element had been replaced three days previously and it was thought that the transmitter may not have been adequately vented at that time, thus allowing entrapped air to indicate spurious flow oscillations. The transmitter was vented and a compliance check for that particular scram was completed satisfactorily. The reactor was then refueled and returned to normal operation.

Major maintenance items for August included: replacing the 6" discharge line gasket on pool heat exchanger 521B; testing the operability and placing on service the new diesel emergency generator; installing new bearings and mechanical seal on primary demineralizer pump 513A; replacing sensing line for primary flow element 912E; installing bismuth/indium filters in Beamport "F" centertube; removing pool pump 508B to the Machine Shop for repair; and replacing nuclear instrument channel #4 detector (wide range monitor) on two separate occasions.

September 1989

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

On September 3, a reactor scram occurred from what was thought to be a spurious reactor loop low flow signal initiated by primary flow element 912E similar to the unscheduled shutdown of August 31. The annunciation for this spurious signal did not lock in on the annunciator board, so the "white rat" scram monitor indications were used to help determine the most likely cause. The transmitter was again vented and a compliance check for that particular scram was completed satisfactorily. No further problems of this nature were experienced.

On September 5, a nuclear instrument channel #4 (wide range monitor) high power scram occurred during a normal reactor startup. No actual high power condition was indicated on any other instrumentation. After troubleshooting efforts, the Electronics technicians subsequently replaced the channel #4 compensation potentiometer and the detector and no further problems have occurred.

On September 8, a reactor scram and isolation was initiated by the area radiation monitor exhaust air plenum alarm unit. All personnel exited the containment building as per procedure. All indications from the remote area radiation monitoring station in the Electronics Shop read downscale, which indicated a probable electrical problem with the area radiation monitor. A Health Physics technician and the shift supervisor reentered the containment building with a portable radiation monitor and found all radiation readings in the containment building at normal background. An Electronics technician determined that a failed resistor in the high voltage circuit of the area radiation monitor had caused the scram and isolation. The resistor was replaced and the area radiation monitor was tested satisfactorily.

On September 18, a nuclear instrument channel #5 (power range monitor) high power rod run-in occurred shortly after entering automatic control during the completion of a normal reactor startup. Immediately prior to the rod run-in, channel #5 was indicating 109%, 5% below the rod run-in set point of 114%. As an operator shimmed the control blades out, channel #5 indication rose to the rod run-in trip set point of 114% before

the automatic insertion of the regulating blade compensated. The rod run-in trip point corresponded to an actual power level of 10.4 MW. The power level indications on the two other power range monitors were within normal operating limits. The rod run-in was reset and the indication for channel #5 was lowered to match the other power range monitors before the reactor was returned to normal operation. The operator involved was instructed to be more aware of his power indications while shimming control blades.

On September 25, an anti-siphon system high level rod run-in occurred soon after completion of a normal reactor startup. The rod run-in was a result of a combination of an air leak at a fitting on the anti-siphon pressure tank and water leaking by the seat of anti-siphon valve 543B. The valve 543B actuator had been worked on during the maintenance day preceding this startup and it appeared that the actuator was not completely closing valve 543B, allowing water to leak by its seat. The combined loss of air pressure and the valve leakage allowed water to accumulate in the alarm sensing leg which resulted in the rod run-in. The stroke for the valve 543B was readjusted so that the valve closed properly and the leaking air fitting on the anti-siphon tank was tightened. The reactor was then returned to normal operation.

The annual emergency preparedness inspection was conducted by Nuclear Regulatory Commission Inspector, Jim Patterson, from September 26 through September 28.

Major maintenance items for September included: replacing inboard/ outboard bearings and mechanical seal on pool pump 508B; replacing compensation potentiometer and detector for nuclear instrument channel #4; installing new relay K-58 in the N.I. channel #4 downscale annunciation circuit; replacing failed resistor in the high voltage circuit of the area radiation monitoring system; replacing inboard/outboard bearings and mechanical seal on primary demineralizer pump 513A; rebuilding the actuators on valve 546A (in-pool heat exchanger) and valve 543B (anti-siphon).

<u>October 1989</u>

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

On October 10, a nuclear instrument channel #5 (power range monitor) high power scram occurred during a normal reactor startup. No actual high power condition was indicated on any other instrumentation. Electronics technicians subsequently discovered, and replaced, a failed dual trip unit in the drawer for this channel. A normal startup was then completed satisfactorily.

On October 23, a nuclear instrument channel #2 (intermediate range monitor) period scram occurred during a normal startup when the drywell for this detector was inadvertently bumped while operators were attempting to physically adjust the drywell for an adjacent detector. The clamps securing the drywell for this detector were tightened and the operators involved were instructed to be more careful when working around sensitive equipment. A normal startup was then completed and the reactor was returned to normal operation.

The reactor was shut down at 2200 on October 29 to commence special maintenance procedure #11 which includes replacement of the reactor beryllium reflector. This maintenance outage was successfully completed and the reactor was returned to full power operations at 1630, November 6, 1989.

This extended maintenance outage to replace the beryllium reflector and four graphite reflectors was accomplished in seven days as opposed to the nine days it took to replace the beryllium reflector in 1981. The experience, tools and knowledge gained during the 1981 beryllium changeout assisted the planning and preparation for this changeout and resulted in a 9 manrem dose savings (see Annual Report Section IX for Health Physics Summary).

To change out the beryllium reflector, the reactor pressure vessel had to be dismantled to the split ring flange and to replace the four graphite reflectors three beam tubes had to be pulled back approximately ten inches. During the course of the maintenance outage, the valve actuators for V507 A/B and V509 were also rebuilt.

Major maintenance items for the month included: rebuilding the actuators for anti-siphon valves 543A and 543B, and for in-pool heat exchanger valves 546A and 546B; renewing the power connector for control blade "D"; replacing the dual trip unit in N.I. channel #5 drawer; removing Beamport "F" centertube; removing the (saddle) air cans in Beamport "A";

loading spent fuel elements in the National Lead fuel shipping cask and transferring them to the beamport floor for temporary storage; replacing two thrust bearings and one line bearing in pool pump 508A; connecting reactor control instrumentation and back up door power to the new uninterruptible power supply (UPS) and placing the UPS on service; rewiring the Elgar AC line conditioner for standby operation and removing from service; and commencing special maintenance procedure #11 which includes replacing the reactor beryllium reflector.

November 1989

The reactor operated continuously in November following completion of the extended maintenance outage with the following exceptions: three shutdowns for scheduled maintenance and refueling; and four unscheduled shutdowns.

On November 6, a reactor loop low pressure scram occurred during a low power (5 kilowatts) test to perform rod worth measurements, when the primary demineralizer loop isolation valves (527E, 527F) were opened. The demineralizer loop had been isolated and depressurized to change the demineralizer prefilters. When the isolation valves were opened after completing this task, a slight (momentary) pressure drop was detected at primary pressure transmitter 943 due to its close proximity to the demineralizer inlet isolation valve (527E), thus initiating the scram. This task is usually, though not always, completed with the reactor shut down and the primary system depressurized. In cases where the primary system is pressurized, the demineralizer prefilters can be isolated locally with manual isolation valves without using the air-operated loop isolation valves (527E, 527F). This results in depressurizing a small portion of the demineralizer loop volume (one filter bank) instead of the entire demineralizer loop. These local manual valves can then be operated slowly to prevent significant pressure changes. The operators involved in this particular case were instructed to follow the accepted method for performing this task with the primary system pressurized.

On November 9, a nuclear instrument channel #3 (intermediate range monitor) period scram occurred while the reactor was operating at a steady state 10 MW. No actual power transient was indicated on any other nuclear instrumentation. The intermediate range short period rod run-in and scrams are designed to assure protection of fuel elements from a continuous startup rod withdrawal accident (HSR, Add. 5, Section 5). If an actual power

transient had occurred at 10 MW, the three power range instrument scram and rod run-in trips would have occurred before a short period trip could occur. The channel #3 detector drywell and the surrounding pool area were visually inspected with no unusual indications noted. A front panel check of channel #3 was completed, no electrical anomalies were indicated, and this particular problem could not be duplicated. The reactor was subsequently returned to normal operation with no further problems of this nature.

On November 14, both of the operating secondary coolant pumps shut down when their substation power supply breaker tripped due to a thermal overload. This occurred when the motor for secondary pump #2 drew excessive current and its local breaker failed to trip, which then caused the substation breaker to trip. This substation breaker supplies power to the local breaker panels for secondary pump #2 and #3. The primary coolant inlet temperature then rose to the high temperature scram set point of 148°F in approximately two minutes, causing a reactor loop high temperature scram. The operators involved in this particular situation did not respond quickly to the changing temperature because they were occupied with determining the cause of the loss of secondary flow. They have since been instructed that in this situation, the standard operating procedure calls for a manual reduction in reactor power if full secondary flow cannot be restored immediately. It was subsequently determined that the motor for secondary pump #2 had an insulation breakdown, requiring a complete rewinding. The local supply breaker for this motor was also replaced.

Later on November 14, the reactor scrammed due to a momentary loss of site electrical power. This was verified by the University power plant. The reactor was refueled and then returned to normal operation.

Major maintenance items for the month included: replacing the beryllium reflector; replacing four graphite wedges; wiring the distribution panels for the UPS; replacing valves 550 C & D (pool to primary check valves); rebuilding the actuators for primary isolation valves 507 A and B; replacing the detector for nuclear instrument channel #2 (intermediate range monitor); installing bismuth/indium filter in Beamport "F"; replacing a blown fuse in the local breaker for primary pump 501A; and replacing the auto transfer switch for emergency electrical distribution with a new "adjustable" switch set at 255 amps.

December 1989

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

On December 2, a nuclear instrument channel #5 (power range monitor) high power scram occurred. No actual high power condition was indicated on any other instrumentation. Channel #5 is one of three power range monitors, all of which will indicate any actual high power condition and will respond by rod run-in or scram. Electronics technicians subsequently discovered, and replaced, a failed trip module in the drawer for this instrument. The reactor was then refueled and returned to normal operation.

On December 11, a rod not in contact with magnet rod run-in occurred when control blade "B" separated from its magnet during a normal reactor startup. The reactor was subcritical when this occurred. The rod drive amphenol connector was checked and the magnet strength was tested satisfactorily. The anvil surface was cleaned and the pull rod was centered within the guide tube. A normal startup was then completed with no further problems of this nature.

Major maintenance items for this month included: replacing the drawer trip module on channel #5; installing a new breaker on secondary pump #2 controller assembly; installing a spare trip actuator amplifier in the rod run-in position; and replacing the source range monitor detector.

January 1990

The reactor operated continuously in January with the following exceptions: six shutdowns for refueling and/or maintenance; and two unscheduled shutdowns.

On January 1, a rod run-in occurred simultaneously with the acknowledgement of an <u>S-1 on limit</u> annunciation. S-1 is an automatically operated hydraulic valve which allows secondary water to bypass the primary heat exchanger according to temperature demand. An annunciation for this valve occurs when it reaches 20% of its full open or full closed position. No unusual or abnormal indications were seen or recorded on any instrumentation at the time of the rod run-in. After examining all reactor indications

and finding no apparent cause, the rod run-in was reset and the reactor was returned to normal operation. The S-1 annunciation was felt to be coincidental and the rod run-in was considered spurious.

On January 31, a manual rod run-in was initiated by the shift supervisor after observing the channel 5 and 6 power range indications drifting down below 95% power. The problem was isolated to channel #4, the wide range monitor. This channel is part of the servo mechanism that automatically maintains reactor power at a preset point. The detector for this channel was replaced and its drywell was repositioned. The reactor was subsequently returned to normal operation.

Major maintenance items for this month included: installing a new air can in Beamport "A"; installing a new ce rtube with silicon filters in Beamport "F"; and replacing channel #4 detector (twice).

February 1990

The reactor operated continuously in February with the following exceptions: four shutdowns for refueling and scheduled maintenance; one shutdown for refueling and a Nuclear Regulatory Commission reactor operator startup examination; and two unscheduled shutdowns.

On February 1, a reactor scram occurred when a Campus Facility electrician inadvertently opened breaker #2 on the uninterruptible power supply (UPS) electrical distribution panel #1, while attempting to secure the breaker for a wall heater in the UPS room. Breaker #2 on the UPS distribution panel #1 supplies power to the UPS. The UPS supplies conditioned power to two distribution panels located in the reactor control room, which, in turn, supply reactor control and instrumentation power. The opening of breaker #2 and the subsequent momentary loss of control and instrumentation power caused the scram. The breaker was immediately reset, restoring power. A pre-critical startup checksheet was completed and the reactor was returned to normal operation upon completion of a hot startup. The Campus Facility supervisor of the electrician involved in this incident was informed and the situation was discussed among Reactor Operations and Campus Facility personnel.

On February 26, a manual rod run-in was initiated by the shift supervisor when no automatic rod run-in occurred subsequent to receiving a channel #4 high power rod run-in annunciation and drawer light. No actual

high power condition was indicated on any instrumentation prior to or at the time of the annunciation. An electronics technician isolated the problem to the dual trip unit for channel #4 (wide range monitor) which he subsequently replaced. The dual trip unit in channel #4 provides a signal indication for the annunciator and drawer light and a separate signal for the trip functions (rod run-in and scram). The electronics technician determined that the signal leg for the annunciator and drawer light was defective and created a spurious annunciator and drawer indication. Before replacing the dual trip unit, a test of the operability of the rod run-in and scram trip functions for channel #4 indicated that the trips operated satisfactorily and in their intended manner. After completing a pre-critical checksheet, which includes a check of all nuclear instrument channels, the reactor was returned to normal operation with no further problems.

Major maintenance items for this month included: performing the biennial emergency drill with emergency support groups outside the MURR; and replacing the dual trip unit in channel #4 (wide range monitor) drawer.

March 1990

The reactor operated continuously in March with the following exceptions: four shutdowns for refueling and scheduled maintenance; one shutdown for a flux trap sample changeout. There were no unscheduled shutdowns.

Major maintenance items for this month included: replacing primary pump 501B with a spare after a leak was detected in the pump shaft seal.

April 1990

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

On April 8, a manual rod run-in was initiated by the duty operator when the outer airlock door failed to operate from its closed position. The cause was determined to be sticking relay contacts in a door sequence control relay. The contacts were cleaned and exercised satisfactorily and the reactor was refueled and returned to normal operation. The affected relays for the outer door were replaced on April 9.

Major maintenance items for this month included: replacing the source range detector; replacing the close position relays in the outer personnel airlock door; adding a third securing pin to the threaded end of all four control blade pull rods; replacing the pool T_C - MV/I multivolt transmitter; and replacing the wide range monitor detector.

May 1990

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

Major maintenance items for this month included: replacing the pool delta-temperature summer; completing the annual containment building leak rate test; and pulling Beamport "F" centertube back four feet.

June 1990

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

On June 6, a reactor scram occurred due to the loss of facility electrical power during a severe thunderstorm. Site power was restored to the facility in approximately fourteen minutes. At the onset of this electrical outage, the emergency generator started satisfactorily and assumed its electrical loads. It was discovered, however, that a main facility exhaust fan (either EF-13 or EF-14) was not operating. EF-13 and EF-14 are redundant, 100 horsepower motor driven exhaust fans--either fan will start upon the failure of the (operating) fan. Electronics technicians discovered blown fuses in the control circuits for both fans. The fuses were replaced and an exhaust fan was started. An emergency generator load test (Compliance Procedure #17) was performed and the exhaust fan operated satisfactorily. The reactor was subsequently refueled and returned to operation.

On June 14, a reactor scram occurred due to the momentary loss of facility electrical power during a severe thunderstorm. Again it was discovered that the ma[illegible]haust system was not operating and that the control power fuses for each fan were blown. The fuses were replaced and an exhaust fan was started. An emergency generator load test was

performed satisfactorily and the exhaust fan(s) operated properly. The reactor was refueled and returned to operation.

Exhaust fans EF-13 and EF-14 and their associated controllers are part of a facility ventilation system upgrade completed in October of 1989. After consultation with the system design engineers and the controller vendor the following modifications were suggested to alleviate the fuse problems: separating the voltage source for control power to each fan so that power for each fan is developed across different phases; increasing the amperage rating of the control fuses from 3 amps to 6.25 amps for each fan which would also require replacement of the 480V/120V transformer currently rated at 250 VA with one rated at 750 VA. The first modification has been completed. The second modification has been completed on EF-13 and will be completed on EF-14 when a second control power transformer arrives. A Licensee Event Report was sent to the Director of Nuclear Reactor Regulation on July 6, 1990 detailing these unscheduled shutdown events and the subsequent corrective actions.

On June 18, a rod not in contact with magnet rod run-in occurred when control blade "A" disengaged from its magnet during a normal startup. The reactor was subcritical at the time this occurred. The anvil and magnet were checked and cleaned and associated wiring was inspected. Rod alignment to the offset tube was checked. No anomalies were noted. A normal reactor startup was then completed with no further problems of this type.

Major maintenance items for this month included: removing the silicon filter centertube from Beamport "F" and installing the iridium/bismuth filter centertube; replacing the control power fuses on exhaust fans EF-13 and EF-14; replacing the reactor temperature (T_c) multivolt transmitter; repairing worn leads on the T_h RTD for the in-pool heat exchanger; and replacing the control circuit transformer on EF-13.

SECTION II

CHANGES TO THE STANDARD OPERATING PROCEDURES

2nd Edition, Effective Date: 5/02/89
(Revisions #1 through #24 to the October 1981 printing were incorporated.)

1 July 1989 through 30 June 1990

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

Revision No. 1, dated 8/14/89
Revision No. 2, dated 1/16/90

CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

(dated January 1985, and revised May 13, 1988)
NOTE: New manual printed May 13, 1988

1 July 1989 through 30 June 1990

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

Revision No. 3, dated 9/18/89
Revision No. 4, dated 12/8/89
Revision No. 5, dated 3/22/90

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

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

STANDARD OPERATING PROCEDURES NANUAL
2nd Edition, Effective Date: 5/02/89
(Revisions #1 through #24 to the October 1981 printing were incorporated.)

Revision Number 1
Revision Date: August 14, 1989

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If direct communications are lost or if one of the above reports is not acknowledged, reactor power will be maintained at a steady level until the problem is corrected. The Health Physics Technician will make his final report to the Control Room after a complete survey is conducted at the desired power level.

I.4.4 Normal Operation

A. Normal power level will be 9.90 to 10.00 MW as indicated by the total power meter.

B. The control room shall be occupied by at least one licensed operator during steady state operation of the reactor. A second licensed operator must be at a facility location where communication with the control room can be maintained.]

C. Prior to assuming control of the reactor, the oncoming operator will read the control room log book and shall be briefed on current operation.

D. During shift operation, the Shift Supervisor for the new shift will review the log book and be briefed on current operations by the crew he is to relieve. Upon completion of the log book review, the Shift Supervisor will note the same in the log book.

E. A complete set of Nuclear data will be taken once an hour during steady state operation.

F. A complete set of Process data will be taken every two (2) hours during steady state operation.

G. During routine operation, a routine patrol of the facility will be made every four (4) hours according to an approved Routine Patrol Checksheet.

H. Normally, the calorimetric determination of the power level can be read directly from the digital readout and entered in the Nuclear Process Data. The cause of any difference between the primary and secondary calorimetric calculations which exceeds 5% (0.5 MW) during steady state full power operation should be determined. The primary power

D. All experimenters will be required to complete an indoctrination training course on the relationship between-his experiment and reactor operations, emergency procedures, and radiation safety.

E. All reactor users shall complete a Reactor Utilization Request form. This request must be reviewed and approved by the Reactor Manager.

F. If an experiment appears to involve new or unevaluated hazards, a review of the proposed experiment by the Reactor Advisory Committee may be requested by the Reactor Manager.

G. The Reactor Manager may require, as deemed necessary for safe operation, that experimental data or operating instructions be on file with the reactor operations organization.

H. All changes in beamport experiments, and intentional flooding or draining of the beam tubes to be performed with the reactor at power will be done only after written approval is initially obtained from the Reactor Manager and after a procedure for so doing has been established. Whenever practical, beamports shall be flooded or drained only after the reactor has been shutdown for at least 12 hours.

I. The insertion and removal of experiments in the center test hole position will be done with the reactor shutdown.

I.4.7 Modification Records

The purpose of the modification record system is to document changes to reactor license related systems as described in Hazards Summary.

These records must include a written safety evaluation which provides the bases for the determination that the change does not involve an unreviewed safety question as defined in 10 CFR 50.59.

I.4.7.1 Procedure for Initiating and Processing Modification Records]

NOTE: Please contact the Modification Records Manager before initiating any modification packages. The original copy of each modification package will be kept separate from the available copies in the file cabinet. The Modification Records Manager will update the originals as necessary.]

A. When initiating a modification, first obtain a blank modification package from the file.]
DO NOT assign a number to the modification package or log it in the notebook at this time!]

B. Complete a preliminary modification proposal. Even though it is preliminary, try to make it as complete as possible. If the proposal requires a drawing or print, include it if available. For assistance, see Modification Records Manager.]

(1) When completing the safety evaluation and unreviewed safety question sections, list the Hazards Summary Report (HSR) and the Technical Specification sections that apply or the reason they are not affected.]

C. When the preliminary proposal is written, submit it for crew review and evaluation. This is where comments and suggestions are solicited. Suggested changes can then be incorporated into the final draft.]

D. After the proposal has been reviewed and necessary changes have been made, submit the final draft to the Reactor Manager for review.]

(1) The Reactor Safety Analysis (pg. 3) should be put in final form. If the modification involves a change to the Facility as defined in the HSR, include suggested revisions to the HSR, referencing the applicable section of the HSR.]

If it does not affect the HSR, then outline the basis for the decision.]

(2) The Reactor Safety Evaluation (pg. 4) should be put in final form at this time if it involves changes to the Technical Specifications or an unreviewed safety question.

E. If the modification is determined by the Reactor Manager to be an improvement, it will then be assigned a number and routed for final crew evaluation. If not, it will not be assigned a number and it will be cancelled at this time.

F. After the final crew review, it will be ready for approval by the Reactor Manager and will be reviewed by the Safety Subcommittee and/or Reactor Advisory Committee as necessary.

G. The modification will then be completed as soon as possible, including updating any necessary prints, Standard Operating Procedures, Compliance Checks or Preventive Maintenances.

H. When these are completed, the modification package will be routed by the Modification Records Manager to the Reactor Manager and signed off as completed.

I.4.8 Radiation Work Permit

A Radiation Work Permit will be completed by the Job Supervisor and Health Physics prior to conducting any work which in the opinion of the Shift Supervisor or the Health Physics Group involves significant potential for exposure of personnel to radiation or the spreading or release of airborne or surface contamination.

A copy of this form is included in the Appendix of the SOP. The form is used as follows:

A. The top portion of the RWP will be prepared by the Job Supervisor and Health Physics. The time and date spaces should contain the supervisor's estimate of the duration of the job (0800-2400 September 2, 1988; 0000-2400 September 10-12, 1988, etc.). The Job Supervisor should be as specific as possible in describing the job. This will aid Health Physics in determining the protective measures necessary.

B. Health Physics will assign a number to the RWP and conduct the necessary surveys and determine the protective measures necessary for the job. Health Physics will complete the remainder of the RWP indicating the survey results and the protective measures required. Health Physics will then sign and date the RWP, and obtain approval signature from the Job Supervisor and information signature from the Shift Supervisor, if appropriate.

C. The Job Supervisor will provide Health Physics with the names of personnel expected to work under the RWP prior to the start of the job. Each person performing work under the RWP shall be informed of the required radiation controls and shall acknowledge being informed by signing on their designated signature line. Health Physics will have available the approved RWP at the job site for ready reference by the personnel doing the work.

D. When the job has been completed and the job site has been cleaned up and decontaminated, the Job Supervisor will deliver the RWP to Health Physics. Health Physics will verify that the job site is clean and decontaminated, and will record estimated dose for each person involved. Health Physics will terminate the RWP and maintain it in an RWP file. Any person who signed approval or any supervisor can terminate the RWP by signing the termination block. Health Physics must be notified if the RWP is terminated by someone other than a member of the Health Physics Group.

I.4.9 Radiation Safety]

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

I.4.10 Physical Protection of Special Nuclear Materials]

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

I.4.11 Equipment Tagout Procedure]

I.4.11.1 Purpose]

The purpose of the tagout system is to prevent injury to personnel and damage to equipment.]
]

I.4.11.2 Types of Tags]

A. Red Tags]
Red tags will be used to identify equipment which, if operated could present a hazard to personnel. The tag will also contain information as to the potential hazard.]
]
]

B. Yellow Tags

Yellow tags will be used to identify equipment which, if operated, could present a hazard to equipment. The tag will alwo contain information as to the potential hazard.

I.4.11.3 Equipment Tagout

A. Tagout Log

1. The tagout log will be maintained in the control room by the on duty shift supervisor.
2. The tagout log will be made up of four sections:
    a. Tagout Instructions
    b. Index
    c. Active Tagout Sheets
    d. Cleared Tagout Sheets

B. Performing a Tagout

1. A tagout will be accomplished by a licensed operator only.
2. The on duty shift supervisor must approve the hanging or removal of any tag.
3. In the event that a tag is missing, the shift supervisor will be informed immediately. The missing tag will be cleared from the tagout sheet and a new tag issued.

C. Tagout Audit

1. A tagout audit will be performed at least monthly.
2. The tagout audit will consist of verifying that the index includes each active tagout and also that each tag for the active tagouts is still in place and correct.
3. Upon completion of the audit, the person completing the audit will sign and date the tagout audit sheet.
4. Upon completion of the audit, all the tagouts in the inactive section of the tagout log may be discarded.

Table III

Normal Reactor Operating Ranges

Parameters	Normal Operating Range	Units
1. Thermal Power, 5 MW Operation	5 ± 5%	MW
2. Thermal Power, 10 MW Operation	$10\ ^{+0\%}_{-5\%}$	MW
3. Primary Coolant Flow, 5 MW Operation	1850 ± 50	gpm
Primary Coolant Flow, 10 MW Operation	3700 ± 50	gpm
4. Reactor Outlet Coolant Temperature	136	°F
5. Reactor Inlet Coolant Temperature	120	°F
6. Pressurizer Pressure	67 ± 3	psig
7. Pressurizer Level	CENTERLINE + 4 to -8	inches
8. Pool Coolant Flow, 5 MW Operation Pool Coolant Flow, 10 MW Operation	600 ± 100 1200 ± 100	gpm gpm
9. Pool Outlet Temperature (Hot Leg)	105	°F
10. Pool Level	29' 7" ± 3"	feet-inches
11. Resistivity, Outlet of DI-300	>500K	ohms-cm
12. S-1 Temperature Demand Set	120	°F
13. S-2 Temperature Demand Set	100	°F

Table IV

Nominal Values of Trip Settings for Alarm, Run-In and Scram Conditions for 10MW Operation

	Scram	Run-In	Alarm	Units
1. Short Period	9	11	- -	sec
2. Low Count Rate	--	--	<1.0	cps
3. High Power	119	114	--	% full power
4. RC Inlet Temp	148	--	140	°F
5. RC Outlet Temp	168	--	160	°F
6. RC System Low Flow 10 MW Operation	[1]1725	--	1800	gpm
7. Heat Exchanger Low ΔP (DPS 928A/B)	[3]1675	--	--	gpm
8. Rx System Low Press Switch PS 944A/B	[2]63	--	--	psig
9. Core Low ΔP, 10 MW	[3]3300	--	--	gpm
10. Low Pressurizer Level	13 below C.L.	--	10 below C.L.	inch
11. High Pressurizer Water Level	--	--	14 above C.L.	inch

[1]Alarm and Scram received from either loop
[2]Pressurizer pressure with normal system flow
[3]ΔP Corresponding to this flow value

TABLE IV (continued)

	Scram	Run-In	Alarm	Units
12. Low Pressurizer Press	63	--	65	psig
13. Hi Pressurizer Press	78	--	75	psig
14. Pool Low Flow, 10 MW	490	--	530	gpm
15. Pool Hi Temp	--	--	115	°F
16. Low Pri Demin Flow	--	--	42.5	gpm
17. Low Pool Demin Flow	--	--	42.5	gpm
18. Bldg Air Plenum Hi Activity	10 x normal operating background	--	--	mr/hr
19. Reactor Bridge	10 x normal operating background	--	--	mr/hr
20. RC Hi Conductivity	--	--	2.0	µmhos
21. PC Hi Conductivity	--	--	2.0	µmhos
22. Hi Refl ΔP, 10 MW	7.0	--	--	psi
23. Low Refl ΔP, 10 MW	3.0	--	--	psi
24. Low N_2 System Press	--	--	115	psig
25. Low Seal Trench Level	--	--	5	feet
26. Hi/Lo Level in T-300	--	--	6200/2500	gal
27. Hi/Lo Level in T-301	--	--	6000/<100	gal

TABLE IV (continued)

		Scram	Run-In	Alarm	Units
28.	Fission Product Monitor Hi Activity	--	--	200	cps
29.	Off-Gas Hi Activity	--	--	[5]see below	cpm
30.	Secondary Coolant Hi Activity	--	--	10	cps
31.	Anti-Siphon Line Hi Level	--	>6 (above valves)	--	inches
32.	Pool Level Low	>24'	>28'	--	feet]
33.	Reg Blade	--	<10% or bottomed	<20% or >60%	% withdrawn
34.	Vent Tank Low Level	--	7-11 (below C)	--	inches
35.	Secondary Coolant Low Flow	--	--	<1800	gpm
36.	Ch 4, 5, or 6 Downscale	--	--	<95	% full-scale
37.	Valve 546 A or B	--	--	off closed	
38.	Valve 509	off open	--	--	
39.	Valve 547	--	--	off open	
40.	Valves 507 A/B	off open	-	closed with P501 on	
41.	Valve S-1	--	--	90% open or 90% shut	--

[5]This setpoint is determined by the semiannual calibration.

TABLE IV (continued)

		Scram	Run-In	Alarm	Units
42.	Nuclear Instrument	[6]inoperative	--	anomaly	--
43.	Anti-Siphon System Pressure Low	--	--	30	psig
	Anti-Siphon System Pressure High	--	--	44	psig
44.	Thermal Column Door	--	--	open	--
45.	Truck Entry	--	door seal deflated	--	--
46.	Evacuation or Isolation	manual/auto	--	manual/auto	--
47.	Rx System Low Pressure (PT-943)	[3]63	--	--	psig

---

[3]Pressurizer Pressure with normal system flow
[6]Any channel will scram on NI Inoperative except SRM

II.1.6 Reactor Shutdown Procedure

A. The procedure for a routine reactor shutdown requires only that the manual rod run-in circuit be activated. However, prior to shutting down the reactor:
   1. Turn on the source range recorder and time and date the chart.
   2. Insert the fission chamber until a count of approximately 10^5 cps is obtained on the SRM recorder.
   3. Place the IRM recorder in fast speed and time and date the chart.
   4. Take a set of nuclear and process data.

B. Depress the manual rod run-in button on the control console. Enter the time of shutdown in the log book.

C. Follow the reactor power decrease by changing the range selector switch so as to keep channel WRM-4 on scale.

D. Complete the Reactor Shutdown Checksheet if the control room is to be left unattended for an extended period.]

E. Ensure that the primary and pool systems are shutdown as per SOP IV.2 and V.2 respectively if the control room is left unattended for an extended period of time.

II.1.7 Reductions in Power

The procedure for reductions in power to perform short evolutions (< 45 minutes) such as Room 114 entry, shall be as follows:

A. Turn on source range recorder and time and date chart.

B. Inset fission chamber until a count of approximately 10^5 cps is obtained on SRM recorder.

C. Place IRM recorder to fast speed and time and date the chart.

D. Take a set of nuclear and process data.

E. Depress the manual rod run-in button on the control console.

F. Drive control rods in 3" or to a height of 21" withdrawn, whichever corresponds to a lower rod height.

G. After evolution is completed, recover power following procedure for hot startup (II.1.2).

H. If the evolution for which the reduction in power is made exceeds or appears that it will extend past 45 minutes, shut down the reactor following procedure II.1.6.

F. During the process of actually removing the offset, the core neutron levels will be continually monitored using the fission-pulse channel SRM-1. The reactor control room may be unattended during the removal operation. All reactor systems will be shutdown.

II.3.2 Caution Should be Taken During Removal as Follows:

A. Due to the potentially high radiation level produced by the activated blade, place the bridge ARMS to the upscale position to prevent a building isolation alarm while the offset is being handled near the surface of the water.

B. Extreme caution should be used during Step II.3.3.L so that undue stress is not placed on offset mechanism while breaking it loose from guide pins. Also, extreme caution should be used while maneuvering the offset mechanism away from the pressure vessel.

II.3.3 The Detailed Procedure for Removal is as Follows:

A. Electrically disconnect the rod drive mechanism.

B. Remove the four bolts at the base of the rod drive mechanism and with either the rod magnet fully inserted or withdrawn, remove the rod drive mechanism.

C. Remove the four bolts at the base to the rod drive shaft housing assembly.

D. Uncouple the amphenol connections to the drop timer/rod bottom photocells. Mark position of photocell housing if it is to be removed.]

E. Remove the "U" clamp attaching the upper housing to the bridge floor plate.

F. The upper housing unit may now be lifted free. Mark the upper housing when more than one mechanism is to be removed.

G. Loosen the bolts on the lower housing bracket and remove same.

G. Verify that the particulate recorder and gas recorder pens indicate 3500 cpm ± 10% and that the stack monitor high activity annunciation is received. Also verify that the local meter reads 3600 cpm ± 10%.]

H. Return the particulate mode switch to "OP" position.

I. Press the "reset" button until the particulate meter and recorder readings return to normal; do not drive it to the downscale position. Reset the annunciator.

J. Test the low flow alarm in the control room by securing the blower.

K. Return the blower switch to "on", verify "high" and "low" alarms cleared.

III.8 Area Radiation Monitoring System

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

The station trip points shall be set as follows:

Station 1-BP South Wall	2 X acceptable background
Station 2-BP West Wall	2 X acceptable background
Station 3-BP North Wall	2 X acceptable background
Station 4-Fuel Vault	10 mr/hr
Station 6-Room 114	2 X normal operating background
Station 7-Reactor Exhaust Plenum	1 mr/hr or 10 X normal operating background
Station 8-Reactor Bridge	50 mr/hr or 10 X normal operating background
Station 9-Reactor Bridge Backup	1 K - 10 K mr/hr

At least once per month the system will be checked according to the following procedure.

V.2 Pool System Shutdown Procedure

V.2.1 The pool cooling system should remain in operation for a short period of time (5 minutes minimum) after a normal reactor shutdown in order to remove core decay heat from the reflector and experimental facility. The procedure for attaining a normal pool system shutdown mode is as follows:

A. Place master switch 1S1 in test.
B. Turn off P508A/B using the control switches in the control room. To minimize check valve slam, secure both pumps simultaneously.
C. Verify that valve V509 closes and cleanup pump P513B shuts off automatically.]
D. Turn cleanup pump P513B switch to off.]
E. Place V509 in the manual/closed position.
F. Verify that all the valve position indicating lights are operating. If not, replace the appropriate light bulb. If this does not clear the malfunction, determine the cause and make repairs prior to any reactor start up.

NOTE: The following steps are at Shift Supervisor's discretion.

G. Turn off the pool flow and temperature recorders.
H. Secure power to P508 A/B.

V.3 Partial Pool Filling Procedures (Pool at Refuel Level or Above)

V.3.1 To increase the water level in the pool with demineralized water from T301 or T300, one of the two following procedures can be used; however, all water in T301 should be used first.

A. Filling may be accomplished with the skimmer system (Section VII.5.3) with or without the skimmer pump operating and the reactor either operating or shutdown. Required operational pool makeup will be accomplished in this manner:
   1. Check capacities of tanks T300 and T301 and check proper valve lineup.
   2. Observe the pool level and check that the skimmer pump is secured.

VI.6.6 Secondary Silt, Algae and Mud Control

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

VI.7 Secondary System Operation on Maintenance/Refueling Days

This section is to be used to ensure sufficient cooling is provided to the LiBr air conditioning unit when a secondary pump is required to maintain primary and/or pool system temperatures.

A. Place P-4 in hand so it will run continuously.

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

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

C. When the reactor is placed in automatic at 10 MW, return P-4 to automatic.

VIII.4.6 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:

- Insure center tube is not left fully inserted; allow at least 1/4 inch for thermal expansion.
- After the center tube is inserted, verify the 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 shut down.

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 include 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, insure 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.

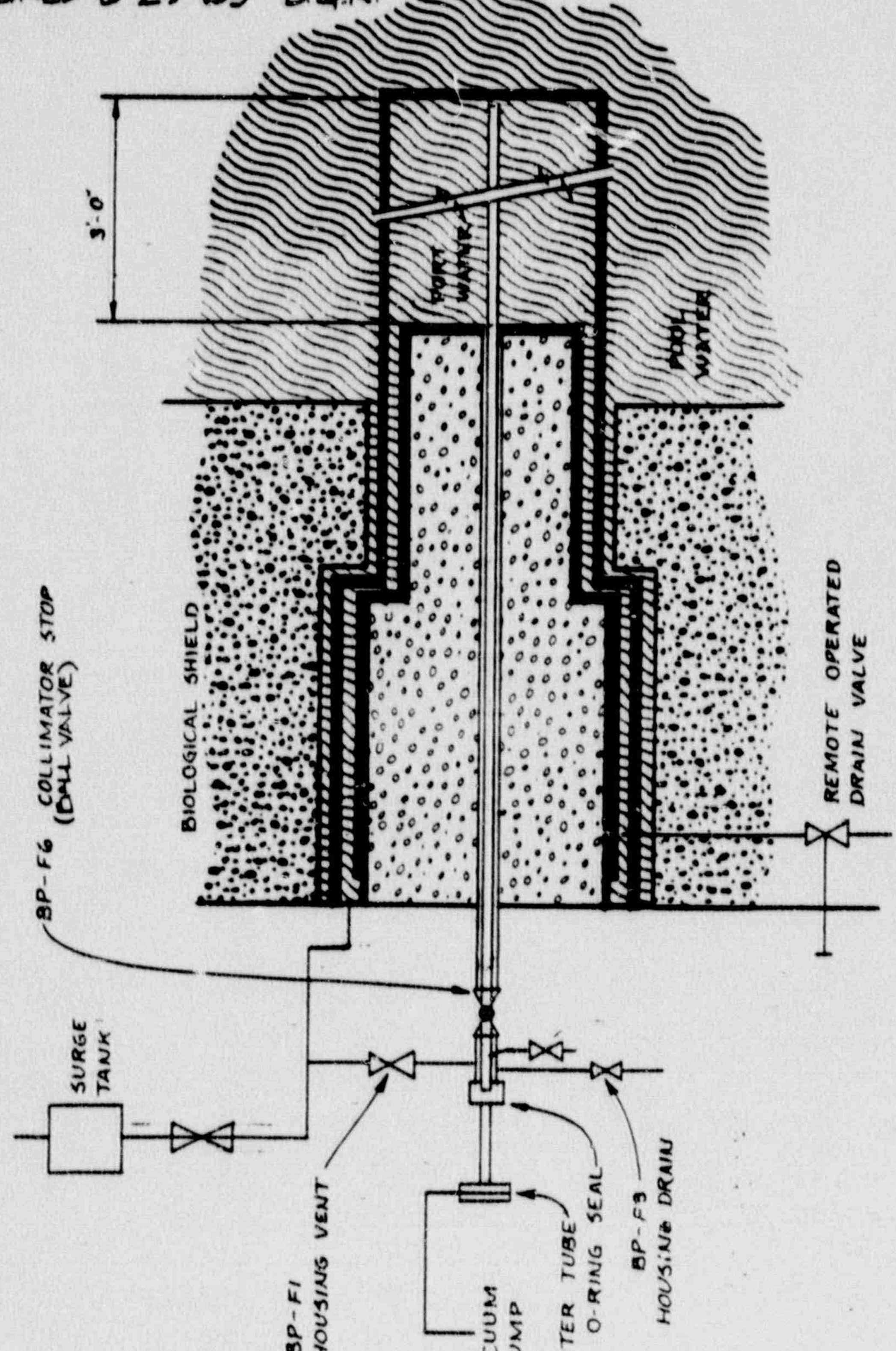
C. Removing Center Tube from Beamport "F"

The center tubes may be very activated. Therefore, close Health Physics assistance is required. Minimize the number of personnel in Beamports "D", "E", and "F" areas while transferring the center tube.

1. The center tube should be allowed to decay for > 2 days before moving from the beamport.]
2. After loosening the packing nut, pull the center tube back slowly, drying the center tube as it is being withdrawn.]
3. When the center tube is one to two feet from being fully withdrawn, attempt to gently close the ball valve (be careful not to score the valve or the center tube).

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

#1 REVISED 6.29.89 D.G.N.



B. SUSTAINED LOSS OF ELECTRICAL POWER

IMMEDIATE ACTIONS:

1. Check the reactor shutdown.

2. Turn OFF all pump and cooling tower fan switches.

3. Place all valve controls in their normal shutdown position and manual mode.

4. Trip the master supply breaker on substation "B".]

SUBSEQUENT ACTIONS:

1. Notify the Shift Supervisor.

2. Check emergency generat r and its loads for proper operation.

3. Check gas tank level a d project remaining run t e of E. G.

4. Determine cause of electrical power loss.

5. If a rabbit is in the reactor, transfer P-tube blower to emergency power and return the rabbit.

6. Trip the supply breakers for MCC-1, MCC-2A and MCC-2B in cooling tower.

7. Make console log entry and fill out UNSCHEDULED SHUTDOWN report.

RECOVERY ACTIONS:

1. Check all three phases on each substation for proper voltages.

2. When starting the system, closely monitor any equipment known to be running at the time of the electrical power loss.

3. A Full Power Startup Checksheet shall be performed prior to starting up the reactor.

C. MOMENTARY LOSS OF ELECTRICAL POWER:
(only a reactor scram occurred)

1. Notify the Shift Supervisor.

2. Verify momentary loss of electrical power with power plant.

3. The reactor may be operated after performing a Reactor Short Form Precritical Checksheet.

4. Make console log entry and fill out UNSCHEDULED SHUTDOWN report.

LOSS OF POOL FLOW DURING REACTOR OPERATION

IF pool flow rate drops below 490 gpm in either loop without generating an automatic scram, the reactor operator shall:

IMMEDIATE ACTIONS:

1. Scram the reactor.
2. Shut down the pool system, leaving the primary and secondary on the line.

SUBSEQUENT ACTIONS:

1. Notify the Shift Supervisor.
2. Determine the cause of pool flow loss and correct it before restarting the reactor.
3. Make console log entry and fill out UNSCHEDULED SHUTDOWN reports.

5. IF the source of activity is determined to be fission products, a further reduction of primary flow to approximately 500gpm is necessary to reduce plate erosion. To accomplish this:

   WARNING: DO NOT ENTER ROOM 114 UNTIL ABSOLUTELY NECESSARY. A HEALTH PHYSICS' SURVEY IS VITAL PRIOR TO ENTRY.]

   a. Fully open the bypass valve (538A or 538B) around the pump that is running.

   b. Throttle valves 540 A and B.

6. Clean up contaminated systems by:

   a. Leaving the primary cooling and primary cleanup loops in operation to clean up the primary system.

   WARNING: THE RADIATION LEVELS IN THE DEMINERALIZER ROOMS MAY BE EXTREMELY HIGH.

7. When equipment and personnel are ready to identify the leaking fuel element, the primary systems should be shut down as per SOP IV.2.

8. Identify the leaking or ruptured fuel element. The fuel element which is leaking fission products must be accurately identified and placed in safe storage before the remaining intact elements may be utilized. This will be accomplished in the following manner:

   a. Have the Health Physics personnel move the portable gaseous and particulate monitors to the reactor bridge for continuous monitoring. Health Physics personnel will be present.

   b. Move each element from the core to the "X" or "Y" basket.

   c. Draw a grab sample from above each element and give to the laboratory group for analysis. If one of these samples indicates fission products present, this element will be inspected first.

   d. Move the fuel element from one of the baskets to the fuel inspection rig for visual inspection.

   e. The Reactor Manager will determine the disposition of the leaking fuel element(s).

REACTOR ROUTINE PATROL Date: ______________

1. Time of start of patrol							
2. Time and date all charts							
3. Check ARMS trip settings							
4. Visual check of entire pool							
5. Anti-siphon tank pressure	36 psig ± 3 psi						
6. North iso door seal pressure	18-28 psig						
7. South iso door seal pressure	18-28 psig						
8. 5^{th} level backup doors	Open						
9. 5^{th} level detector reading	0-3.5 mr/hr						
10. 5^{th} level trip point set	3.5 mr/hr						
11. 16" iso vlv A air pressure	45-55 psig						
12. 16" iso vlv B air pressure	> 90 psig						
13. Emerg compress on standby	Bkr closed, vlv open, gage 90-120 psig						
14. Containment hot sump pumps	Operable						
15. Door 101 seal pressure	18-28 psig						
16. BP floor	Conditions normal.						
17. Fuel vault	Locked						
18. Inner airlock door seal press.	18-28 psig						
19. Outer airlock door seal press.	18-28 psig						
20. Cold deck temperature	51 ± 4°F						
21. T-300 level	> 2000 gal.						
22. T-301 level	< 6000 gal.						
23. Labyrinth sump	Level < Alarm Pt.						

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.

EACTOR ROUTINE PATROL

24. RO unit power	ON						
25. RO unit temperature	24-28°C or Standby						
26. RO unit pressure	190-200 psig or Standby						
27. EG Rm. (Batt. check Sun. mids.) (EG OP switch to Auto) (Gas | sight glass)	Thermostat > 50°F Temp > 40°F						
28. T-300, 301 Room	Thermostat > 55°F Temp. > 40°F						
29. Rm. 114 particulate filter ΔP	< 2.5" H_2O						
30. External doors	All locked except east when sec on duty.						
31. CT basin water level	5-10"						
32. Automatic secondary makeup vlv	Auto or Open						
33. Acid day tank level	Visible						
34. CT sump pumps	Operable						
35. P-pump(s) running							
36. Pump strainer ΔP	0-7.0 psi						
37. Discharge pressure							
38. Pump strainer ΔP	0-7.0 psi						
39. Discharge pressure							
40. Tunnel sump pumps	Operable						
41. WT booster fan	Running						
42. Acid control and pH	Flow 400-800 cc/min (Range as posted)						
43. Blowdown control/cond.	Flow 500-800 cc/min (Range as posted)						
44. Fission product monitor flow	95-105 cc/min						
45. Vlv control header pressure	90-120 psig						
46. Pressurizer N_2 supply press	90-100 psig						
47. Check rm. 114 from door.							
48. Deltech oil filter "red level" and blowdown	< 75% dark red						
49. Seal trench	61-66" Run pump on days.						

50. Full N_2 bottles	Total > 3						
51. Bank A bottle pressure	> 250 psig						
52. Bank B bottle pressure	> 250 psig						
53. Bank on service	A or B						
54. N_2 header pressure	135-145 psi						
55. Waste tank #3 level							
56. Waste tank #2 level							
57. Waste tank #1 level							
58. Doors to Ct, WT's, Demin. Rm. 114 and CT Tunnel	Locked						
59. Time of completion of patrol							
60. Operator initials							

REMARKS: ____

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PRIMARY SYSTEM NORMAL OPERATION VALVE LINEUP CHECKSHEET (cont'd)

		Valve #	Valve Description	Position
_____	56.	568E	FE-923A valve manifold	Inlet/outlet open; equaliz. closed
_____	57.	595H	Primary sample valve	Open
_____	58.	515U	V-527A cutout valve	Open
_____	59.	515AA	Press drain to drain collection system.	Open 1/2 turn (locked)]
_____	60.	515B	V-527C cutout valve	Open
_____	61.	515S	V-527D cutout valve	Open (locked)
_____	62.	544	V-545 cutout valve	Open
_____	63.	599G	PZR local level indicator cutout	Closed (locked)
_____	64.	599H	PZR local level indicator cutout	Closed
_____	65.	515AB	Pressurizer drain to waste system.	Closed
_____	66.	515C	P-533 suction	Open (locked)
_____	67.	599A	PS-938 cutout	Open
_____	68.	599B	PS-939 cutout	Open
_____	69.	599C	PS-940 cutout	Open
_____	70.	599D	PS-941 cutout	Open
_____	71.	599E	PS-945 cutout	Open
_____	72.	599F	PS-946 cutout	Open
_____	73.	599N	FE-913A drain	Closed
_____	74.	599O	FE-913A drain	Closed
_____	75.	599V	FE-913B drain	Closed
_____	76.	599W	FE-913B drain	Closed

COMMENTS: ____

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Operator

STANDARD OPERATING PROCEDURES NANUAL
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<u>Page Number</u>

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SOP/VI-9

SOP/VII-29

SOP/A-1A

SOP/A-8a

SOP/A-8b

SOP/A-14a

SOP/A-14b

B. Yellow Tags

Yellow tags will e used to identify equipment which, if operated, could present a hazard to equipment. The tag will also contain information as to the potential hazard.]

I.4.11.3 Equipment Tagout

A. Tagout Log

1. The tagout log will be maintained in the control room by the on duty shift supervisor.
2. The tagout log will be made up of four sections:
    a. Tagout Instructions
    b. Index
    c. Active Tagout Sheets
    d. Cleared Tagout Sheets

B. Performing a Tagout

1. A tagout will be accomplished by a licensed operator only.
2. The on duty shift supervisor must approve the hanging or removal of any tag.
3. In the event that a tag is missing, the shift supervisor will be informed immediately. The missing tag will be cleared from the tagout sheet and a new tag issued.

C. Tagout Audit

1. A tagout audit will be performed at least monthly.
2. The tagout audit will consist of verifying that the index includes each active tagout and also that each tag for the active tagouts is still in place and correct.
3. Upon completion of the audit, the person completing the audit will sign and date the tagout audit sheet.
4. Upon completion of the audit, all the tagouts in the inactive section of the tagout log may be discarded.

TABLE IV (continued)

	Scram	Run-In	Alarm	Units
28. Fission Product Monitor Hi Activity	--	--	200	cps
29. Off-Gas Hi Activity	--	--	[5] see below	cpm
30. Secondary Coolant Hi Activity	--	--	10	cps
31. Anti-Siphon Line Hi Level	--	<6 (above valves)	--	inches
32. Pool Level Low	>24'	>28'	--	feet
33. Reg Blade	--	<10% or bottomed	<20% or >60%	% withdrawn
34. Vent Tank Low Level	--	<-11 (below C)	--	inches
35. Secondary Coolant Low Flow	--	--	<1800	gpm
36. Ch 4, 5, or 6 Downscale	--	--	<95	% full-scale
37. Valve 546 A or B	--	--	off closed	
38. Valve 509	off open	--	--	
39. Valve 547	--	--	off open	
40. Valves 507 A/B	off open	--	closed with P501 on	
41. Valve S-1	--	--	90% open or 90% shut	--

[5] This setpoint is determined by the semiannual calibration.

H. Unscrew lift rod assembly and lift up as far as it will go. Remove lift rod and lower housing as one unit.

I. Using bolt removal tool, loosen offset mechanism hold down bolt on rear of assembly.

J. The lifting and removal of the offset can be accomplished by using a center pull lifting rod, the J-shaped "T" lifting tool, or in some cases both tools. If using the center pull rod, thread the rod in snug and raise the blade to full out. If using the "T" lifting tool, insert the pulling tool into the hole in the counter balance arm and raise the blade to full out, then insert the "T" section of the lift tool into the lifting lug at the top rear of the offset.]

K. Attach the lifting tool to the crane.

L. Jog the crane while lifting by hand until the offset mechanism lifts free of the side guide pins. Observe closely the strain necessary to break the offset free. If the offset mechanism does not break loose from its reflector platform after applying a reasonable amount of tension, relieve the tension on the lifting tool and determine the reason for the difficulty before continuing the attempt to lift the mechanism.

M. After the offset mechanism has cleared the guide pins, carefully raise it until the top of the blade mount is about 1/8" below the pressure vessel intermediate flange.

NOTE: After the mechanism clears the guide pins, the blade is still partially within the gap so caution must be observed to hold the mechanism steady while raising it to the flange above or the blade may be damaged.

N. With the blade now clear from its gap, carefully move the mechanism away from the pressure vessel "spool" flange and raise the mechanism to the surface.

CAUTION: The lower portion of the mechanism and the lower tip of the blade will be very radioactive, so insure close Health Physics coverage is provided before raising the blade to the pool water surface.

II.3.4 Installation of the Control Blade Offset Mechanism

The procedure for installing the blade and offset mechanism is essentially the reverse of th. above, with a particular emphasis on the following points:

A. Before inserting the mechanism, check the clearance of the blade gap with the gapping tool.
B. After disengaging the lifting tool, the Shift Supervisor or Senior Operator will exercise the blade over its full length of travel until he is convinced that the blade moves freely and is able to travel through the gap totally without resistance.]
C. During the subsequent pull for the rod drop test, determine the position at which the photocell for the drop timer actuates with respect to the blade full-in position. It must not be greater than 5.2".

II.4 Waste Tank Analysis

A waste tank analysis is performed by the laborator[illegible] for evidence of activity prior to release to the sanit[illegible] sewer. See Section VII.8.6. A pH of each sample is measured to determine its acidity. If the waste water is very [illegible]cidic (pH less than 4) and the liquid waste is to be held, a caustic solution should be added and circulated to prevent excess corrosion of the waste tanks.

4. Press source check push button and monitor point of trip, verifying the following to have occurred:
   a. Scram and rod run-in trip actuator amplifier tripped.
   b. Building air plenum high activity scram alarm indicated on annunciator.
   c. Evacuation or isolation scram alarm indicated on annunciator.
   d. 16" isolation valves indicate closed.
   e. Containment isolation horns have sounded.
   f. Isolation doors MO-504 and MO-505 indicate closed.
   g. Supply and return fans have secured.
   h. Red flasher light outside outer containment door is flashing.
   i. Alarm buzzer on ARMS module is alarming.
5. If more than one check is required,
   a. The horn cutout switch may be used to silence the containment horns.
   b. The 16" isolation valves cutout switch may be turned to the off position, leaving the valves closed.
   c. The motor operated isolation doors may be left in the closed position.
6. When the checks have been performed as required, reset the tripped Channel 7, 8, or 9 trip.
7. Trip the backup door radiation monitor with the attached source. (Trip set pointer may have to be lowered to obtain trip.) Verify that the items in 4 above are initiated by the monitor trip. Reset the monitor.]
   (Return trip set pointer to proper setpoint if moved.)]
8. Close the 16" isolation valve cutout switch, verify the valves indicate open.
9. Open isolation doors MO-504 and MO-505 by depressing the open push button for 5 seconds after the fans start.
10. Perform the visual inspection of the ventilation system on the fifth level.
11. Turn the ARMS detector channel selector switch to Channel 5.

3. Remotely open valve 565B from the primary/pool drain collection system control panel. Insure valve does indicate open.

4. The skimmer pump may be started at this point. However, it will fill by gravity if desired.

5. When proper pool level is obtained, secure the skimmer pump and remotely close valve 565B. Insure it does indicate closed.

B. The second approved method of filling the pool is via the 4" line from tank T300/301 to the pool pump suction and discharge line.

1. Check capacities of tanks T300 and T301 and check proper valve lineup.

2. With the pool system in the normal shutdown mode, filling the pool through a pool pump can be avoided by opening valve V522C and permitting T301 or T300 to drain by gravity feed alone.

3. Close valve V522C when the filling operation is completed.

V.4 Pool Lowering Procedure

V.4.1 Lowering Pool Water Level to Refuel Bridge

Two methods of lowering pool level may be used:

A. By use of the skimmer system (SOP/VII.5.2).

B. By use of the pool pumps P508A or P508B as outlined below.

V.4.2 Before a lowering of the pool level using P508A/B is commenced, place pool system in service as follows:

A. Isolate one pool heat exchanger utilizing the local inlet gate valve.

B. Place master switch 1S1 to test.

C. Place V509 to manual/open.

D. Start P508A or 508B.

B. Check valves V515M, V515X (P513B bypass) and V515Q closed for normal operation.

NOTE: Opening V515M and closing V515T bypasses flow around valve V509, HUT-504 and P508A/B to the input of P513B. Opening V515Q and closing V515P returns processed water to the suction side of P508A/B rather than back to the top side of the pool.

C. Make certain that one of three possible demineralizer units is valved into the cleanup system according to the procedures described in Section VII.

D. Turn on demineralizer flow recorder. Time and date the strip chart.

E. Turn on P513B from the control room by turning the P513B control switch to the ON position.

F. Verify a 50 ± 5 gpm flow rate on the pool cleanup loop flow recorder.

G. Indicated flow rate should be 50 ± 5 gpm and the indicated water purity should be less than 2.0 μmhos/cm from the demineralizer.

V.5.2 Discharging Excess Water from Primary or Pool System with T301 Full - moved to SMP-2C.

V.6 Single Pool Pump Operating Procedure]

NOTE: This procedure will be accomplished after a need has been determined to secure one of the pool pumps and only with the reactor shutdown and a radiation survey of the work area in room 114 completed.]

A. Shut down the reactor.]

B. Secure the pool system.]

C. Open the breaker for the pump to be secured at the motor control center.]

D. Lock out the run/stop switch at the pump to be secured.]

V.6

E. Close the pump suction and discharge valves (on the pump to be secured). Perform appropriate system tagout.]

F. Check fully open the suction and discharge valves on the operating pump.]

G. Fully open valves 522 A/D (Pool HX discharge valves).]

H. Place the pool system back on line.]

I. Monitor pool flow, reflector D/P, pool demineralizer flow.]

NOTE: Trip point for reflector ΔP may have to be reset for single pump operations.]

J. Adjust pool flow potentiometer.]

K. Note in the control console log that single pool pump operation has commenced.]

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SECTION VI
SECONDARY COOLING SYSTEM

VI.1 Startup of the Secondary System

A. Before attempting to start up the secondary system, it should be determined that:

1. Water level in the cooling tower basin is between 5 and 14 inches.
2. All personnel are clear of cooling tower equipment and fans.
3. Oil level in the gear reducers to the fans is normal.
4. The automatic sump makeup water isolation valve electrical power switch is in auto.

B. The following manually operated valves in the cooling tower should be in positions indicated:

Open			Closed	
S-17	S-9	S-105	S-129	
S-18	S-10	S-106	S-101	
S-19	S-11	S-107	S-126	
S-20	S-12	S-108	S-121	
S-21	S-118	S-109	S-123	
S-22	S-119	S-110	S-125	
S-155	S-120	S-111	S-127	
S-5	S-117	S-112	S-113	]
S-6	S-114	S-163	S-102	]
S-7	S-115	S-128		
S-8	S-116			

C. The following valves in equipment room 114 passageway and waste tank room should be in the positions indicated:

Open		Closed		
S-152	S-151	S-103	S-169	
S-153	S-150	S-160		]
S-104	S-159			
S-170				]

D. The following valves in equipment room 114 should be in the position indicated:

Open		Closed	
S-161	S-26	S-132	S-144
S-162	S-41	S-133	S-145
S-131	S-43	S-27	S-154
S-130	S-34	S-28	S-134
S-23	S-35	S-29	S-135
S-24	S-45	S-137	S-136
S-25		S-140	S-138
S-39		S-141	S-139
S-30		S-142	S-157
S-31		S-143	S-158

E. For operation of the chiller units with feed water from P-1, P-2, P-3, or P-4, the following valves in room 278 should be in the positions indicated as follows:

Open		Closed	
S-53	S-57	S-54	S-149
S-55	S-58	S-146	

F. Verify that the Bailey Meter recorder Model E101 in the reactor control room is on to monitor secondary flow and temperature during operation. Time and date chart. Secondary outlet temperature for each heat exchanger can be monitored in the control room with the digital readout and selector switch.

G. Verify that the circuit breakers for P-1, P-2, P-3 and P-4 on MCC-2 in the cooling tower are closed and that the control switch on the pannels is in <u>auto</u> mode.

VI.6.3 Secondary Water pH Control

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

VI.6.4 Sample Paths for pH and Conductivity

A. During normal operation of the secondary system, the automatic pH and conductivity control units receive their sample water through valves S104 and S151.
B. During operation of the secondary system with the air conditioning units secured and isolated, close S104 and open S103. This provides a representative sample for these units to control pH and conductivity.]
C. The pH and conductivity units shut down when secondary pumps (P-1, P-2, and P-3) are secured.

VI.6.5 Secondary Water Corrosion Prevention

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

VI.6.6 Secondary Silt, Algae and Mud Control

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

VII.8.12 Chemical Precipitate Treatment

A. Drain the waste tank to WT2.

B. Lower the waste tank water pH.

1. Check all valves at R200 closed.
2. Line up acid mixing tank valves and close the pump breaker.
3. Open R200 valves RE57, RE58, RE5 and RE70.
4. Start acid pump at R200 station and throttle flow with RE58.
5. Add sufficient acid (6 normal) to lower pH to between 5.0 amd 6.0.
6. Secure the acid pump and open the breaker.
7. Shut valves RE5, RE57, RE58 and RE70.
8. Drain and flush the acid mixing tank.
9. Close the acid mixing tank valves.

C. Sparge and recirculate, bypassing the filters, for 30 minutes.

D. Add a special carrier solution which will be provided by the Laboratory Group.

E. Sparge and recirculate, bypassing the filters, for one hour.

F. Raise the pH.

1. Open the WT2 manhole cover.
2. Add sufficient sodium hydroxide to raise the pH to 11.0-14.0.

   CAUTION: It is better to add too much than not enough.
3. Replace the manhole cover.

G. Sparge and recirculate, bypassing the filter, for 30 minutes.

H. Secure W.T. recirculation and let tank settle for 24 to 48 hours.

Then pump (<u>without</u> air sparge) through stand pipe, from WT2 to WT1.

I. WT1 should now be ready to sample.

J. Recirculate WT2 through filter until they no longer foul up,]
disposing of used filters in drying rack.]

K. Remaining water in W.T. #2 should now be ready to sample.]

REACTOR STARTUP CHECKSHEET
FULL POWER OPERATION

DATE: ______
TIME (Started): ______

BUILDING AND MECHANICAL EQUIPMENT CHECKLIST

[ ] 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. (Required if shutdown longer than 4 hours.)
   [ ] b. Test stack monitor and low flow alarm per SOP while in west tower.
[ ] 4. Emergency generator availability/status checked. (If shutdown for greater than 24 hours, run emergency generator for 30 minutes.)]
[ ] 5. Emergency pool fill. (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. P501A and P501B coolant water valves open.
   [ ] b. Pump controllers unlocked to start (as required).
   [ ] c. Check valves 599A and 599B open.
   [ ] d. Air valve for valve operating header (VOP31) open.
   [ ] e. N_2 back-up valve open.
   [ ] f. Air/N_2 cross connect valve open.
   [ ] g. S1 and S2 hydraulic pumps on (oil level normal).
   [ ] h. Valves S1 and S2 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.
   [ ] n. Check oil reservoir for pumps 501A, 501B, and 533 for adequate supply. Add if necessary.
   [ ] m. 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.

REACTOR CONTROL SYSTEM CHECKLIST

[ ] 1. All chart drives on; charts timed and dated. IRM recorder to slow.
[ ] 2. Fan failure warning system cleared.
[ ] 3. Annunciator board energized; horn off.
[ ] 4. Television receiver on.
[ ] 5. Primary/pool drain collection system in service per SOP. (Manually pump DCT)
[ ] 6. Secondary system on line per SOP (as needed).
7. Primary system on line per SOP:
   [ ] a. Primary cleanup system on line.
8. Pool system on line per SOP:
   [ ] a. Pool cleanup system on line.
   [ ] b. Pool reflector ΔP trips set as required.
9. Nuclear Instrumentation check completed per SOP:
   [ ] a. The following trip values were obtained during the check:

IRM-2, run-in	______	seconds (11±1)	Scram	______	seconds (9±1)
IRM-3, run-in	______	seconds (11±1)	Scram	______	seconds (9±1)
WRM-4, run-in	______	% (114±1)	Scram	______	% (119±1)
PRM-5, run-in	______	% (114±1)	Scram	______	% (119±1)
PRM-6, run-in	______	% (114±1)	Scram	______	% (119±1)

REACTOR ROUTINE PATROL Date: ________________

1. Time of start of patrol							
2. Time and date all charts							
3. Check ARMS trip settings							
4. Visual check of entire pool							
5. Anti-siphon tank pressure	36 psig ± 3 psi						
6. North iso door seal pressure	18-28 psig						
7. South iso door seal pressure	18-28 psig						
8. 5th level backup doors	Open						
9. 5th level detector reading	0-3.5 mr/hr						
10. 5th level trip point set	3.5 mr/hr						
11. 16" iso vlv A air pressure	45-55 psig						
12. 16" iso vlv B air pressure	> 90 psig						
13. Emerg compress on standby	Bkr closed, vlv open, gage 90-120 psig						
14. Containment hot sump pumps	Operable						
15. Door 101 seal pressure	18-28 psig						
16. BP floor	Conditions normal.						
17. Fuel vault	Locked						
18. Inner airlock door seal press.	18-28 psig						
19. Outer airlock door seal press.	18-28 psig						
20. Cold deck temperature	45° + 55°F						
21. T-300 level	> 2000 gal.						
22. T-301 level	< 6000 gal.						
23. Labyrinth sump	Level < Alarm Pt.						
24. RO unit power	ON						

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.

25. RO unit temperature	24-28°C or Standby							
26. RO unit pressure	190-200 psig or Standby							
27a. UPS RM	No Alarms Indicated Thermostat > 55°F Temp > 40°F							]
27b. T-300, 301 Room	Thermostat > 55°F Temp. > 40°F							]
28a. EG Rm. (Perform complete checklist--SUNDAY)	Thermostat > 60°F Temp > 50°F							]
28b. Battery charging current	< 1 amp.							]
28c. Battery Voltage	> 28V							]
29. Rm. 114 particulate filter ΔP	< 2.5" H_2O							
30. External doors	All locked except east when sec on duty.							
31. CT basin water level	5-10"							
32. Automatic secondary makeup vlv	Auto or Open							
33. Acid day tank level	Visible							
34. CT sump pumps	Operable							
35. P-pump(s) running								
36. Pump strainer ΔP	0-7.0 psi							
37. Discharge pressure								
38. Pump strainer ΔP	0-7.0 psi							
39. Discharge pressure								
40. Tunnel sump pumps	Operable							
41. WT booster fan	Running							
42. Acid control and pH	Flow 400-800 cc/min (Range as posted)							
43. Blowdown control/cond.	Flow 500-800 cc/min (Range as posted)							
44. Fission product monitor flow	95-105 cc/min							
45. Vlv control header pressure	90-120 psig							
46. Pressurizer N_2 supply press	90-100 psig							
47. Check rm. 114 from door.								
48. Deltech oil filter "red level" and blowdown	< 75% dark red							
49. Seal trench	61-66" Run pump on days.							

Date ______________

POOL SYSTEM VALVE LINEUP CHECKSHEET

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

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

		Valve #	Valve Description	Position	
______	1.	598A	Air supply to 546	Open	
______	2.	555P	Air supply valve to V-547	Closed	
______	3.	548A	P-532 pool suction	Open	
______	4.	548B	P-532 pool (at refuel) suction	Closed	
______	5.	518U	Vent valve (pool T_H)	Closed	]
______	6.	515X	P-513B bypass	Closed	
______	7.	515N	P-513B discharge	Open	
______	8.	518H	P-513B suction gage cutout	Open	
______	9.	518G	P-513B discharge gage cutout	Open	
______	10.	522C	Pool drain/fill	Closed	]
______	11.	522B	Pool fill	Closed	]
______	12.	515Q	Cleanup return to loop	Closed	]
______	13.	515M	Cleanup suction from pool	Closed	]
______	14.	515T	Cleanup suction from loop	Open	
______	15.	522F	P-508A discharge	Open	
______	16.	522E	P-508B discharge	Open	
______	17.	531B	P-508B bypass	Closed	
______	18.	518I	P-508A gage cutout	Open	
______	19.	518J	P-508A gage cutout	Open	
______	20.	518AD	P-508B gage cutout	Open	
______	21.	518AC	P-508B gage cutout	Open	
______	22.	599J	PS-947 cutout	Open	]
______	23.	539A	P-508A suction	Open	]
______	24.	539C	P-508B suction	Open	]

POOL SYSTEM VALVE LINEUP CHECKSHEET (cont'd)

		Valve #	Valve Description	Position	
_____	25.	518V	Vent valve	Closed	]
_____	26.	515P	Cleanup return to pool	Open	
_____	27.	514B	HUT outlet	Open	
_____	28.	539B	HX-521A inlet	Open	
_____	29.	539D	HX-521B inlet	Open	
_____	30.	522A	HX-521A outlet	Throttled	]
_____	31.	522D	HX-521B outlet	Throttled	]
_____	32.	518N	HUT vent cutout	Open	
_____	33.	518K	HUT vent	Closed	]
_____	34.	515R	HUT drain	Closed (locked)	
_____	35.	515O	HX-521A drain	Closed	]
_____	36.	515Z	HX-521B drain	Closed	]
_____	37.	518W	Vent valve	Closed	]
_____	38.	518AG	Pool system "Y" strainer drain	Closed	
_____	39.	518Q	Drain valve (tunnel)	Closed	]
_____	40.	518R	Drain valve (tunnel)	Closed	]
_____	41.	514A	V-509 cutout	Open	]
_____	42.	568G	PT-917 cutout valve	Open	
_____	43.	599Z	PT-917 vent	Closed	
_____	44.	599Y	P-532 suction vent	Auto Float	
_____	45.	515I	P-532 suction	Open	
_____	46.	518D	P-532 gage cutout	Open	
_____	47.	518C	P-532 gage cutout	Open	
_____	48.	515E	Skimmer filter inlet	Open	
_____	49.	515D	Skimmer filter outlet	Open	
_____	50.	567A	Drain collection pump suction	Open	
_____	51.	567B	Drain collection pump suction drain	Closed	
_____	52.	566	Drain collection system discharge	Open	
_____	53.	567C	Drain coll sys disch to 513B suction	Open	
_____	54.	593	Skimmer suction T-300/T-301	Open	
_____	55.	518AJ/AK	HX-521 A/B loop vents	Closed	]

MURR SITE EMERGENCY PROCEDURES AND
FACILITY EMERGENCY PROCEDURES

Revision Number 3
Revision Date: September 18, 1989

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SEP-7	2
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SEP-7	4
EMERGENCY CALL LIST	
FEP-3	1

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. Mark initial needle positions on analog display with the time for future analysis if the control room display becomes inaccessible.

   d. Verify flow rate through monitor is 7 ± 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 100 rem for life-saving, 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.]

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 Watch Office 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. Philip Lee	882-7221	445-5275
Jamison 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 AND CLINICS (UMH&C) — Ambulance 882-6003

The UMH&C should be contacted in the event of personal injury. In the event of personal contamination or radiation exposure without injury, see MEDICAL EMERGENCY PROCEDURES. — Walk-in 882-8091

If three or more personnel are involved, ask the Administrator-On-Duty to implement the Radiation Disaster Plan. Refer to the MEDICAL EMERGENCY PROCEDURES for details.

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

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

e. COLUMBIA FIRE DEPARTMENT — 24 hours 9-911

The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability. Insure Office of University Relations is also called.

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 Watch Office to open RPDB.

CONTACT	Office	Home
Dr. Philip Lee	882-7221	445-5275
Jamison Shotts	882-7221	474-2194
David Spate	882-7221	657-9450

b. UMC POLICE

24 hours
882-7201

The UMC Police may be called to restrict entry to the research park and to assist in partial site area evacuation if deemed necessary.

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

Ambulance
882-6003

Walk-in
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 MEDICAL EMERGENCY PROCEDURES.

If three or more personnel are involved, ask the Administrator-On-Duty to implement the Radiation Disaster Plan. Refer to the MEDICAL EMERGENCY PROCEDURES for details.

d. MU NEWS BUREAU

See SEP-7, PUBLIC INFORMATION PROCEDURE]

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

e. COLUMBIA FIRE DEPARTMENT

24 hours
9-911

The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability. Insure Office of University Relations is also called.

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 Watch Office to open RPDB.

CONTACT	Office	Home
Dr. Philip Lee	882-7221	445-5275
Jamison 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 research park and to assist in partial site area evacuation if deemed necessary.

24 hours
882-7201

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

Ambulance
882-6003

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

Walk-in
882-8091

If three or more personnel are involved, ask the Administrator-On-Duty to implement the Radiation Disaster Plan. Refer to the MEDICAL EMERGENCY PROCEDURES for details.

d. MU NEWS BUREAU

See SEP-7, PUBLIC INFORMATION PROCEDURE

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

e. COLUMBIA FIRE DEPARTMENT

24 hours
9-911

The Columbia Fire Department shall be notified in the event of fire or need of emergency rescue capability. Insure Office of University Relations is also called.

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 offsite emergency assistance is requested via 911; or whenever deemed appropriate by the EMERGENCY DIRECTOR.]

A. INITIAL RELEASE OF PUBLIC INFORMATION

1. The Emergency Status Report shall be completed and approved by the EMERGENCY DIRECTOR.

2a. During normal University office hours, activate the MU News Bureau by calling 882-6211, 882-6214 (Mary Still) or 882-9142 (Marty Oetting).]

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)	Mary Still	(314)-875-4730	]
(2)	Marty Oetting	(314)-474-5126	]
(3)	Ken Brogdon	(314)-442-5260	]
(4)	Helen Fiengo	(314)-442-8046	]

3. Read the Emergency Status Report as approved by the EMERGENCY DIRECTOR to the MU News Bureau staff member and answer any questions concerning definitions, terms, units. etc.]

4. Record other questions that the MU News Bureau staff member may have. Enter the name of the MU News Bureau staff member contacted and give the completed report to the EMERGENCY COORDINATOR to be kept with the records of the EMERGENCY.]

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

VERIFICATION LIST FOR MURR EMERGENCIES

Name	Soc. Sec. No.	Name	Soc. Sec. No.
Chuck Anderson		Sue Langhorst	
Joe Baskett		Charlie McKibben	
Rita Bonney		Walt Meyer	
Kenneth Beamer		Steve Morris	
Barry Bezenek		Phil Neel	
Ron Dobey		Leslie Powell	
Chester Edwards		Mike Randolph	
John Ernst		Bill Reilly	
Christine Errante		Tony Schoone	
Mac Evans		Jim Schuh	
Les Foyto		Tom Seeger	
John Fruits		Vickie Spate	
Greg Gunn		Ray Stevens	
Robert Hudson		Nolan Tritschler	
Rolly Hultsch		Robert Walker	
Brenda Johnson		Mike Wallis	
Vernon Jones		Tim Warner	
Mike Kilfoil		Burle Warren	
Ron Kitch			

6. MU News Bureau personnel contacted will determine the need for staffing and equipping an emergency information center and will call in the required staff and arrange for necessary facilities.

7. MU News Bureau personnel will inform news media and others of the public, as necessary, of the emergency.

8. If possible, a MU News Bureau staff member will be sent on site to assist the EMERGENCY DIRECTOR with the release of information.

B. SUBSEQUENT RELEASE OF PUBLIC INFORMATION

The nature of the emergency and the required response (fast or slow moving) may affect the release of subsequent information.

1. If time permits, fill out an EMERGENCY STATUS REPORT for each release of information.

2. If time does not permit filling out an EMERGENCY STATUS REPORT for each release of information, the EMERGENCY DIRECTOR may verbally approve information to be released by the MU News Bureau staff personnel on site.

3. MU News Bureau will provide updates on information concerning the emergency to the general public and media at periodic intervals or as it becomes available from the EMERGENCY DIRECTOR.

4. In the event of injury to personnel, the EMERGENCY DIRECTOR will be responsible for contacting relatives. MU News Bureau staff will not release names of injured personnel until cleared to do so by the EMERGENCY DIRECTOR and <u>only</u> after relatives or next of kin have been notified.

5. MU News Bureau will continue its operations until the emergency is officially terminated by the EMERGENCY DIRECTOR or until emergency information services are deemed to be no longer necessary.

6. Following the termination of the emergency, MU News Bureau will arrange a meeting between emergency officials and the news media. MU News Bureau will also conduct a critique of its activities and will seek feedback from the media and public on the effectiveness of its procedures.

C. RECORDS AND EMERGENCY LIST VERIFICATIONS

1. All EMERGENCY STATUS REPORTS shall be maintained by the EMERGENCY DIRECTOR or EMERGENCY COORDINATOR as a permanent record of the emergency.

2. The MU News Bureau staff call list and the MURR verification list will be reviewed and revised annually to keep the names and numbers current.

EMERGENCY STATUS REPORT

Date: ______________________

MU NEWS BUREAU STAFF MEMBER CONTACTED: ____

THIS (IS/IS NOT) A DRILL

A. DESCRIPTION OF EMERGENCY

1. What happened and where specifically did it happen? (i.e. reactor containment or laboratory building)

2. When did it happen?

3. Why/how did it happen?

4. Releases, if any, of radioactive material onsite or offsite?

B. EMERGENCY ASSESSMENT

1. Extent of damages and/or injuries?

2. Extent of external danger to general public?

3. Actions taken to protect the general public?

4. Emergency classification declared?

C. ADDITIONAL INFORMATION

1. When will more details be available?

2. When can media speak with EMERGENCY DIRECTOR?

Filled in by: ______________________________

Approved by: ______________________________
EMERGENCY DIRECTOR

Time ________ Date ____________

EMERGENCY PROCEDURE
EMERGENCY CALL LIST

Health Physics

	Phone No.
S. Langhorst	442-3534
R. Stevens	442-2539
J. Ernst	445-5621]
R. Dobey	443-4513]
J. DeMers	445-2204

Director's Office

	Phone No.
S. Morris	445-4217
J. C. McKibben	442-6728

Operations

	Phone No.
W. A. Meyer	442-7675
C. Edwards	443-7529
T. Schoone	474-6416
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
R. Hudson	875-0451
V. Jones	445-2543
M. Kilfoil	474-6285
P. Neel	442-8693]
M. Randolph	442-5315]
R. Walker	445-8077]
M. Wallis	443-8764
T. Warner	816-882-6740
B. Warren	445-2204]

Rev. 9/18/89 App'd [signature]

Operations

	Phone No.
M. Evans	698-2450
K. Beamer	682-5499]
R. Kitch	696-3710]
C. Kribbs	682-3930
T. Seeger	875-8656
J. Baskett	474-2046]

Reactor Chemistry

	Phone No.
M. Glascock	474-8390
J. Schuh	874-3086
V. Spate	657-9450

Emergency Support Organizations

	Phone No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital and Clinics	
Ambulance	882-6003 or 9-911
Walk-in	882-8091
UMC Health Physics (Office)	882-7221
Dr. Phil Lee (Home)	445-5275
Jamison 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 882-9142]
State Emergency Management Agency (SEMA)	314-751-2748
NRC, Region III	312-790-5500
(ANI)	203-677-7305

FEP-3

FIRE PROCEDURE

1. Any individual discovering fire shall notify reactor control (#13) of fire, giving nature and location of fire. The Shift Supervisor will activate the FACILITY EMERGENCY ORGANIZATION by page system and provide warning to stay clear of fire location.

2. SHIFT SUPERVISOR will call (9-911) to notify Columbia Fire Department.

3. EMERGENCY DIRECTOR will investigate the fire and determine steps to minimize hazard to both personnel and property.

   NOTE: An assessment of offsite radiological consequences shall be determined. This assessment may require escalating emergency response to a site emergency procedure (Unusual Event, Alert).

4. The EMERGENCY DIRECTOR may contact the MU News Bureau to handle public information, if appropriate.]

5. If the fire cannot be put out immediately with local fire extinguishers - the reactor WILL be shutdown to focus on fire.

6. Secure EF-13 and EF-14.

7. Secure ventilation supply and exhaust fans and close all fire doors.

8. If the fire is in containment and cannot be immediately brought under control, initiate reactor isolation.

MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

Revision Number 4
Revision Date: December 8, 1989

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EMERGENCY CALL LIST	
WORKSHEET C	

SEP-2

UNUSUAL EVENT PROCEDURE

ACTIONS LEVELS:

IF there is:

a. Report or observation of severe natural phenomenon.

b. Threats to or breaches of security.
[See REACTOR EMERGENCY PROCEDURE (REP-22).]]

c. Concentration of airborne radioactivity at the stack monitor exceeding 3800 MPC when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).]]

NOTE: USE OVERLAY I TO DETERMINE EXTENT OF ACTIVITY FOR IODINE AND PARTICULATE. USE OVERLAY II TO DETERMINE EXTENT OF GASEOUS ACTIVITY.

d. The projected concentration of airborne radiological effluents at the distance corresponding to the nearest site boundary exceeding 10 MPC when averaged over 24 hours.

e. Prolonged fire or explosion within the facility that can result in a release of radioactivity that would cause exposures of the public or staff approaching 1 rem whole body or 5 rem thyroid.

f. Other plant conditions exist that warrant assuring emergency personnel are available to respond to an emergency to prevent exposures of 1 rem whole body or 5 rem thyroid to the public or staff.

THEN at least an UNUSUAL EVENT condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization (FEO), as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE if not already activated.

2. Operations shall provide information to the EMERGENCY DIRECTOR/EMERGENCY COORDINATOR.

3. If airborne activity is involved, continue with step 4. If not, go to step 7.

4. Time and date stack monitor charts for reference.

SEP-3

ALERT PROCEDURE

ACTIONS LEVELS:

IF there is:

a) Concentration of airborne radioactivity at the stack monitor exceeding 19,000 MPC when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).]]

NOTE: USE OVERLAY I TO DETERMINE EXTENT OF ACTIVITY FOR IODINE AND PARTICULATE. USE OVERLAY II TO DETERMINE EXTENT OF GASEOUS ACTIVITY.

b) The projected concentration of airborne radiological effluents at the distance corresponding to the nearest site boundary exceeding 50 MPC when averaged over 24 hours.

c) Radiation levels at the distance corresponding to the nearest site boundary of 20 mrem/hr for 1 hour whole body or 100 mrem thyroid dose.

d) Loss of physical control of the facility.

e) Other plant conditions exist with a level of significance of a major failure of fuel cladding but primary and containment boundaries exist t[illegible]uce releases.

THEN at least an ALERT condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization, as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.

2. Operations shall provide information to the EMERGENCY DIRECTOR/EMERGENCY COORDINATOR.

3. Time and date stack monitor charts for reference.

4. Shut down the reactor.

SEP-4

SITE AREA EMERGENCY PR CEDURE

ACTIONS LEVELS:

IF there is:

a) Concentration of airborne radioactivity at the stack monitor exceeding 95,000 MPC when averaged over 24 hours. [See REACTOR EMERGENCY PROCEDURE (REP-21).]

NOTE: USE OVERLAY I TO DETERMINE EXTENT OF ACT VITY FOR IODINE AND PARTICULATE. USE OVERLAY II TO DETERMINE EXTENT OF GASEOUS ACTIVITY.

b) The projected concentration of airborne radiological effluents at the distance corresponding to the nearest site boundary exceeding 250 MPC when averaged over 24 hours.

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

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

THEN a SITE AREA EMERGENCY condition exists.

IMMEDIATE ACTIONS:

1. Activate the Facility Emergency Organization, as per ACTIVATION OF FACILITY EMERGENCY ORGANIZATION PROCEDURE, if not already activated.

2. Operations shall provide information to the EMERGENCY DIRECTOR/EMERGENCY COORDINATOR.

3. Time and date stack monitor charts for reference.

4. Shut d wn the reactor.

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

VERIFICATION LIST FOR MURR EMERGENCIES

Name	Soc. Sec. No.	Name	Soc. Sec. No.
Chuck Anderson		Sue Langhorst	
Joe Baskett		Charlie McKibben	
Rita Bonney		Walt Meyer	
Kenneth Beamer		Steve Morris	
Barry Bezenek		Phil Neel	
Joe DeMers	]	Leslie Powell	
Chester Edwards		Mike Randolph	
John Ernst		Bill Reilly	
Christine Errante		Tony Schoone	
Mac Evans		Jim Schuh	
Les Foyto		Tom Seeger	
John Fruits		Vickie Spate	
Greg Gunn		Ray Stevens	
Robert Hudson		Nolan Tritschler	
Rolly Hultsch		Robert Walker	
Brenda Johnson		Mike Wallis	
Vernon Jones		Tim Warner	
Mike Kilfoil		Earle Warren	
on Kitch			

6. MU News Bureau personnel contacted will determine the need for staffing and equipping an emergency information center and will call in the required staff and arrange for necessary facilities.

7. MU News Bureau personnel will inform news media and others of the public, as necessary, of the emergency.

8. If possible, a MU News Bureau staff member will be sent on site to assist the EMERGENCY DIRECTOR with the release of information.

EMERGENCY PROCEDURE
EMERGENCY CALL LIST

Health Physics

	Phone No.
S. Langhorst	442-3534
R. Stevens	442-2539
J. Ernst	445-5621
J. DeMers	445-2204

Director's Office

	Phone No.
S. Morris	445-42
J. C. McKibben	442-6728

Operations

	Phone No.
W. A. Meyer	442-7675
C. Edwards	443-7529
T. Schoone	474-6416
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
R. Hudson	875-0451
V. Jones	445-2543
M. Kilfoil	474-6285
P. Neel	442-8693
M. Randolph	442-5315
P. Walker	445-8077
M. Wallis	443-8764
T. Warner	816-882-6740
B. Warren	445-2204

Rev. 12/08/89 App'd WAM

Operations

	Phone No.
M. Evans	698-2450
K. Beamer	682-5499
R. Kitch	696-3710
C. Kribbs	682-3980
T. Seeger	875-8656
J. Baskett	474-2046

Reactor Chemistry

	Phone No.
M. Glascock	474-8390
J. Schuh	874-3086
V. Spate	657-9450

Emergency Support Organizations

	Phone No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital and Clinics	
Ambulance	882-6003 or 9-911
Walk-in	882-8091
UMC Health Physics (Office)	882-7221
Dr. Phil Lee (Home)	445-5275
Jamison 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 882-9142
State Emergency Management Agency (SEMA)	314-751-2748
NRC, Region III	708-790-5500]
(ANI)	203-677-7305

WORKSHEET C

CONTENT OF INITIAL/FOLLOWUP EMERGENCY MESSAGES TO THE NRC REGION III 708-790-5500

1. Name, title, telephone number of caller (882-4211 or 874-4119)

   Name & Title: ______________________________

   Telephone Number of Caller ______________________________

   Location of emergency ev

2. Description of emergency event and emergency class. (NOTIFICATION OF UNUSUAL EVENT, ALERT, or SITE AREA EMERGENCY)

3. Date and time of event initiation.

   Date: ______________ Time: ______________

4. Type of expected or actual release with estimated exposure time.

5. Quantity of radionuclides released or expected to be released.

6. Impact of releases and recommended emergency actions.

EMERGENCY DIRECTOR AUTHORIZATION TO CALL ______________________________

Rev. 12/08/89 App'd WWM

MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES

Revision Number 5
Revision Date: March 22, 1990

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FEP-1	5*
FEP-1	6* Orig.
FEP-1	7* Orig.
FEP-3	1

*Dated 5/22/90 in error.

EMERGENCY PROCEDURE
EMERGENCY CALL LIST

Health Physics

	Phone No.
S. Langhorst	442-3534
R. Stevens	442-2539
J. Ernst	445-5621
J. DeMers	443-4938]

Director's Office

	Phone No.
S. Morris	445-4217
J. C. McKibben	442-6728

Operations

	Phone No.
W. A. Meyer	442-7675
C. Edwards	443-7529
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
R. Hudson	875-0451
V. Jones	445-2543
M. Kil[illegible]	449-2524]
[illegible] Neel	442-8693
M. Randolph	442-5315
R. Walker	445-8077
M. Wallis	443-8764
T. Warner	816-882-6740
B. Warren	443-4938]

Rev. 3/22/90 App'd [signature]

Operations

	Phone No.
M. Evans	698-2450
K. Beamer	682-5499
R. Kitch	696-3710
C. Kribbs	682-3980
T. Seeger	875-8656
J. Baskett	474-2046

Reactor Chemistry

	Phone No.
M. Glascock	474-8390
J. Schuh	874-3086
V. Spate	657-9450

Emergency Support Organizations

	Phone No.
UMC Police	882-7201
Columbia Fire Department	9-911
UM Hospital and Clinics	
Ambulance	882-6003 or 9-911
Walk-in	882-8091
UMC Health Physics (Office)	882-7221
Dr. Phil Lee (Home)	445-5275
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 882-9142
State Emergency Management Agency (SEMA)	314-751-2748
NRC, Region III	708-790-5500
(ANI)	203-677-7305

FEP-1

FACILITY EVACUATION PROCEDURE

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

ENTRY CONDITIONS:

1. The Facility Evacuation alarm is actuated manually from two locations:

   (a) the reactor control room, and (b) the lobby control center.

2. Situations that may warrant FACILITY EVACUATION include:

   (a) Security emergencies, such as a bomb threat.

   (b) A major facility fire.

   (c) Whenever airborne radioactivity is expected to exceed 5 MPC throughout the facility.

   (d) This procedure may be used as part of a Site Emergency Procedure (SEP).

   (e) Other conditions occur that the Shift Supervisor determines warrant personnel evacuation from the facility.

AUTOMATIC ACTIONS:

The following events result from a Facility evacuation alarm:

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

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

A. IMMEDIATE ACTIONS:

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

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

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

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

He shall report to the EMERGENCY COORDINATOR and advise him of the status of the reactor.

MANAGER OF HEALTH PHYSICS shall proceed to the lobby control center and establish the radiation-safe condition of the area. He shall establish a hot-cold change area, assemble and prepare for use special Health Physics equipment, and perform radiation and contamination surveys. He shall evaluate the extent of radioactive contamination and/or radiation exposure received by personnel in the Facility at the time of the incident. He shall advise the EMERGENCY DIRECTOR of measures to be taken to control and to clean up 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 Dr. Philip Lee, 2 Research Park Dev. Bldg.	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.

II. PERSONNEL WITHOUT PREASSIGNED TASKS:
(Staff other than Facility Emergency Organization members)

A. IMMEDIATE ACTIONS:

1. Upon hearing the evacuation alarm, personnel shall proceed to points beyond the area bounded by the outer perimeter of the reactor laboratory building.

2. TOUR GUIDES shall be responsible for the safe evacuation of visitors in their charge from the Facility in accordance with the evacuation routes in this plan. VISITORS shall be monitored by Health Physics Technicians as per HP-20 before being released to leave the site.

3. EXPERIMENTERS who are conducting experiments in the containment area shall render their experimental apparatus safe for unattended operation. They shall be responsible for the safe evacuation of visitors in their charge from the facility in accordance with the evacuation routes in this plan.

4. EVACUATION ROUTES (See the map of the routes on page 6.):

   A. All personnel within the containment building will exit the containment building and proceed through the east door of the laboratory building and then go to the upwind parking lot.

   B. All laboratory personnel, support personnel, and guests exterior to the containment building will leave the facility through the nearest exit (north, east, or south doors) and then proceed to the upwind parking lot.

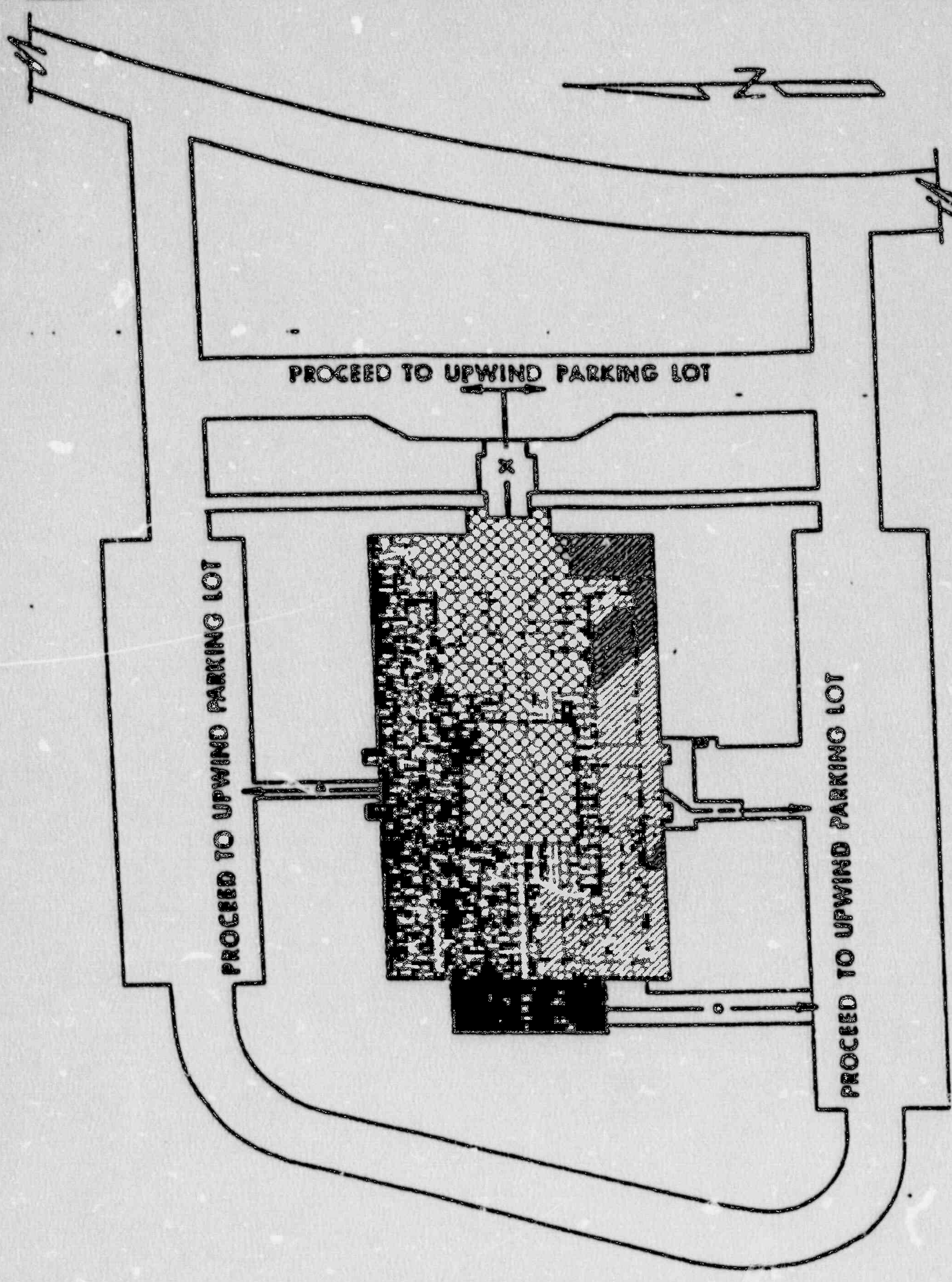
5. Once outside, personnel shall note the wind direction indicator at the top of the containment building east tower and proceed to the upwind parking lot.

B. SUBSEQUENT ACTIONS:

1. All staff personnel shall remain on standby, unless released by the EMERGENCY DIRECTOR, to provide the special services that may be required to restore normal operation.

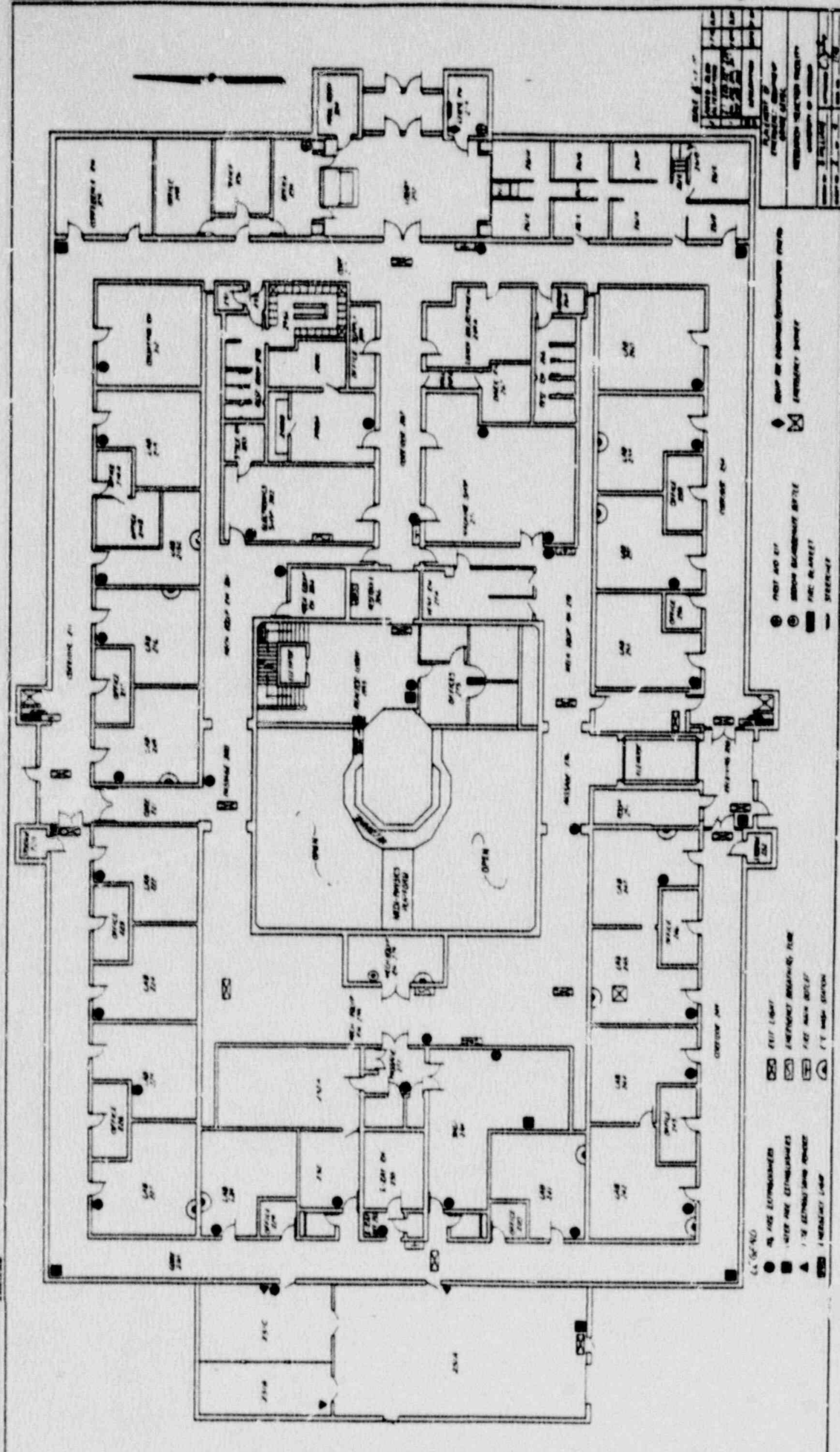
2. All staff personnel shall be monitored by Health Physics Technicians as per procedure HP-20 before being released to leave the site.

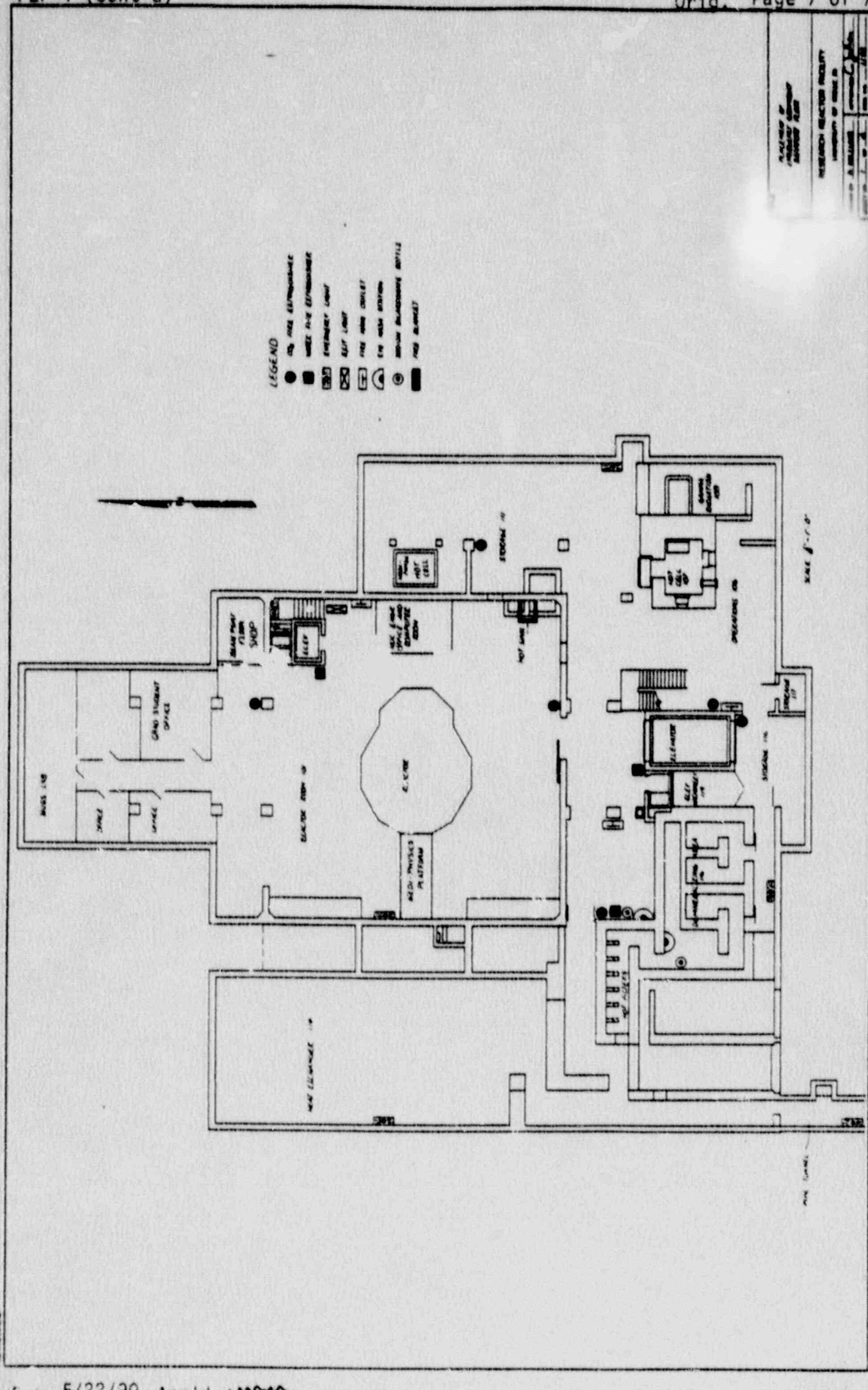
3. A roster of all released personnel will be maintained by the EMERGENCY COORDINATOR.



EVACUATION ROUTES, RESEARCH REACTOR FACILITY
FIGURE FEP-1

Rev. 5/22/90 App'd WMM





Rev. 5/22/90 App'd [signature]

FEP-3

FIRE PROCEDURE

1. Any individual discovering fire shall notify reactor control (#13) of fire, giving nature and location of fire. The Shift Supervisor will activate the FACILITY EMERGENCY ORGANIZATION by page system and provide warning to stay clear of fire location.

2. SHIFT SUPERVISOR will call (9-911) to notify Columbia Fire Department.

3. EMERGENCY DIRECTOR will investigate the fire and determine steps to minimize hazard to both personnel and property.

   NOTE: An assessment of offsite radiological consequences shall be determined. This assessment may require escalating emergency response to a site emergency procedure (Unusual Event, Alert).

4. The EMERGENCY DIRECTOR may contact the MU News Bureau to handle public information, if appropriate.

5. If the fire cannot be put out immediately with local fire extinguishers - the reactor WILL be shutdown to focus on fire.

6. Secure EF-13 and EF-14.

7. Secure ventilation supply and exhaust fans and close all fire doors.

8. If the fire is in containment and cannot be immediately brought under control, initiate reactor isolation. If fire is in laboratory building and cannot be immediately brought under control, initiate Facility evacuation.

9. The EMERGENCY COORDINATOR or EMERGENCY DIRECTOR should contact the Fire Department outside of the Facility and stay in contact with the INCIDENT COMMANDER to coordinate fire fighting and life saving efforts.

   NOTE: The Fire Department INCIDENT COMMANDER coordinates all Fire Department/ medical assistance personnel. The EMERGENCY DIRECTOR or his representative should meet the first fire truck on the scene outside of the Facility. The first ambulance at the emergency scene is designated for triage (sorting and allocation of treatment by injury priority) and will not provide transport for injured personnel.

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT
1 July 1989 through 30 June 1990
HAZARDS SUMMARY REPORT (original July 1, 1965)

1. Original Hazards Summary, Section 3
   Cooling Tower Below Grade Plan, Figure 3.9

   Delete original Figure 3.9 and replace with new Figure 3.9 (See page III-2),revised due to removal of unused water softeners.

2. Original Hazards Summary, Section 7.1.4
   Emergency Power System (pp 7-2, 7-3, 7-4)

   Delete Section 7.1.4 of original Hazards Summary and replace with the following:

   7.1.4 <u>EMERGENCY POWER SYSTEM</u>

Attached to the southwest corner of the reactor laboratory building is an addition that houses the emergency diesel generator and provides space for future addition of a 1250 KW substation. The emergency generator is a 275 KW diesel engine driven unit. Operation of the engine and generator is automatic. It starts one second following failure of normal power. After reaching rated voltage and frequency, the unit will automatically assume the emergency electrical load. Upon restoration of the normal electrical power source, the emergency electrical load will be automatically shifted after an adjustable delay time and the engine will be stopped after an additional adjustable time delay.

The emergency generator (EG) is powered by an 855 cu. in., 395 h.p., diesel unit with a direct injection fuel system. The diesel EG is sized to meet current and anticipated loads with an excess capacity approaching 50% for future load additions. The unit is designed to assume the emergency load within seven seconds of a cold start.

The generator is rated for an output of 344 KVA (275 KW at 0.8 PF), 277/480 volt, three phase, 60 cycles. The emergency power generator will provide for the electrical requirements of the following systems:

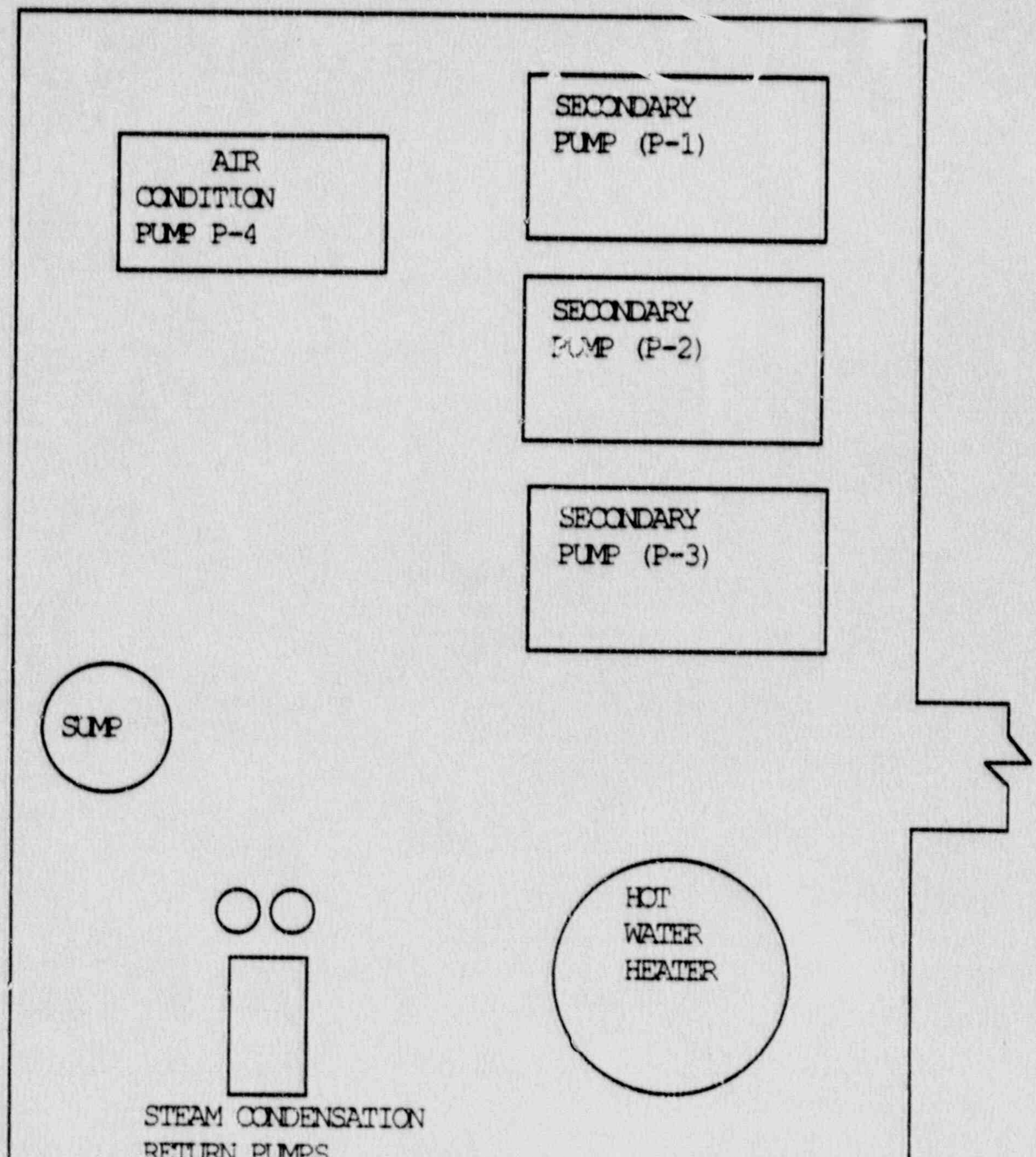


Figure 3.9 Cooling Tower Below Grade Plan

(1) Reactor Control Room Instrumentation

(2) Personnel Entry Doors and Controls

(3) Supply and Exhaust Air Doors and Controls

(4) Facility Exhaust Fans (EF-13 and EF-14)

(5) Emergency Air Compressor

(6) Evacuation/Isolation Alarm System

(7) Fan Failure Warning Light System

(8) Communication and Paging System

(9) Exit Signs

(10) Isolated Lights

(11) Stairway Lighting

(12) Diesel Generator Electrical Controls

(13) Offgas Stack Monitor

The system will be tested once per week for 30 minutes to assure operability.

Periodic maintenance will be performed according to manufacturer's recommendations.

3. Original Hazards Summary, Section 7.2.3
General Watersofteners.

Delete this section in its entirety. This system has been removed.

4. Original Hazards Summary Report, Secti[illegible] 7, Paragraph 7.2.7. Ventilation and Air Treatments (p. 7-1[illegible]

Delete original paragraph and revisions submitted in 1974 Annual Report. Replace with the following paragraphs:

> The Research Reactor Facility building complex is totally air conditioned. The building air intakes are located on the north and south faces of the east reactor containment building tower and include two roof top air handlers (RTAH) in the laboratory building roof [one mid way on each of the north and south corridors]. Building air is exhausted through a stack in the west tower.
>
> Air from the laboratory fume hoods is passed through a system of absolute filters prior to being mixed with reactor containment building exhaust air and passes out of the building through the stack in the west tower.
>
> Reactor containment building air that is discharged to the atmosphere is thermal column cooling air, beamport ventilation air, air which is drawn from the surface of the pool and exhaust from the film irradiator shield box. Reactor containment building exhaust air is mixed with and diluted by the laboratory building exhaust air. The reactor cooling equipment room ventilation air and the pneumatic tube system exhaust air pass through filters and then also exhaust through the building stack.

5. Hazard Summary Report, Addendum 1, Section 3.8

Delete Section 3.8, including Figure 3.8.1 and replace with the following:

> The emergency power system is driven by a water cooled Cummins, six cylinder, turbocharged diesel engine. It is provided with a 270 gallon skid mounted diesel fuel storage tank and a mechanically driven fuel injection system. It is capable of assuming full load from a cold start in seven seconds. A 24 volt, nickel-cadmium storage battery is used for the EG starting system.

Attached to the diesel engine is a four pole generator equipped with a brushless permanent magnet exciter. It produces 60 cycle, 277/480 volt, 3 phase power and has a continuous standby capacity of 275 KW. The design of the exciter and regulator provides for voltage regulation of better than plus or minus 2%. Stable generator output voltage and frequency are established within two seconds after the transition between no load and full load conditions.

The automatic transfer switch (ATS) is equipped with an adjustable .5 to 3 second delay on starting, preventing plant operation on instantaneous line failures, and an adjustable 0 to 25 minute delay on retransfer to commercial power. Incorporated in the unit is a static type dual rate float/equalizer charger with automatic and manual charge control to maintain the startup battery fully charged.

The emergency bus is routed through the automatic transfer switch to an Emergency Distribution Panel (CTR-1) shown on Figure 3.8.1. This distribution Panel feeds the following emergency electrical loads:

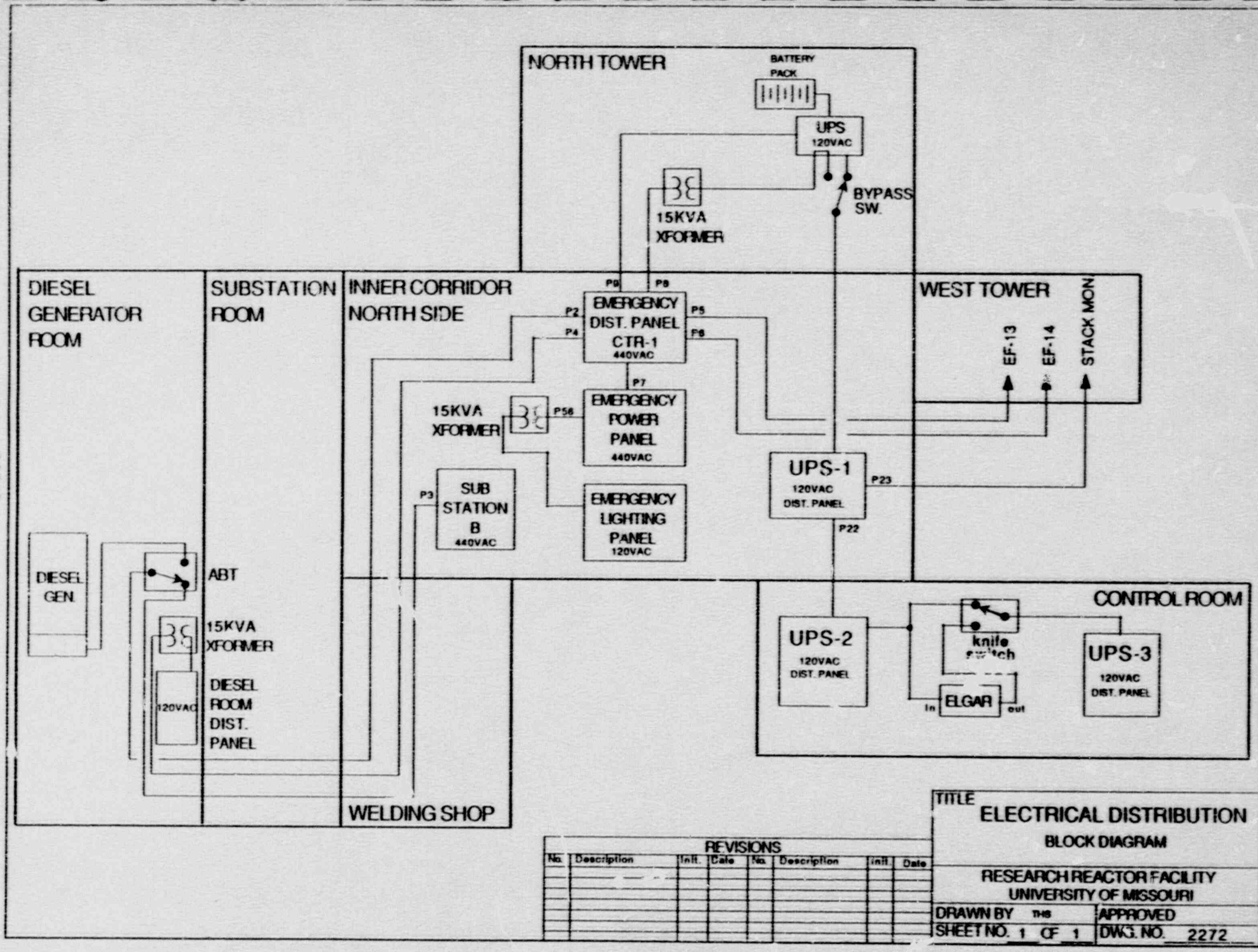

NORTH TOWER
BATTERY PACK
UPS
120VAC
BYPASS SW.
15KVA XFORMER
P9
P8
DIESEL GENERATOR ROOM
SUBSTATION ROOM
INNER CORRIDOR NORTH SIDE
WEST TOWER
EMERGENCY DIST. PANEL CTR-1
440VAC
P2
P4
P5
P6
P7
EF-13
EF-14
STACK MON
15KVA XFORMER
P56
EMERGENCY POWER PANEL
440VAC
UPS-1
120VAC DIST. PANEL
P23
P22
P3
SUB STATION B
440VAC
EMERGENCY LIGHTING PANEL
120VAC
DIESEL GEN.
ABT
15KVA XFORMER
120VAC
DIESEL ROOM DIST. PANEL
CONTROL ROOM
UPS-2
120VAC DIST. PANEL
knife switch
ELGAR
In
out
UPS-3
120VAC DIST. PANEL
WELDING SHOP
REVISIONS
No. Description Init. Date No. Description Init. Date
TITLE
ELECTRICAL DISTRIBUTION
BLOCK DIAGRAM
RESEARCH REACTOR FACILITY
UNIVERSITY OF MISSOURI
DRAWN BY THS
APPROVED
SHEET NO. 1 OF 1
DWG. NO. 2272

Figure 3.8.1

1) Exhaust Fan EF-13

2) Exhaust Fan EF-14

3) Diesel Room Distribution Panel which provides control power for the EG room ventilation system.

4) Emergency Power Panel which feeds through a transformer and distribution panel to supply exit lights, stairway lights, fan failure alarm, intercommunications system, and the evacuation alarms. This emergency power panel also feeds the emergency air compressor, the motorized isolation doors, the truck entry door and the pedestrian entry doors.

5) 120 volt distribution panel via either and uninterruptible power supply or a line conditioner. This distribution panel provides the following loads:

   a) Stack Offgas Monitor

   b) Reactor Control Power (control rods, rod run-in, safety system, and Servo amplifier)

   c) Annunciator Panel

   d) Area radiation monitoring system

   e) Neutron and Process Monitoring Instruments

The generator will run for approximately 30 minutes weekly under no load conditions. The generator is load tested on at least a semi-annual interval.

6. Hazards Summary Report, Addendum 1, Section 3.22, (pp 101-102)

Delete Section 3.22 in its entirety and replace with the following:

"Submit drawings showing the general arrangement of the ventilation systems and associated dampers and controls for the containment and laboratory areas."

Figures 3.22.1 and 3.22.2 illustrate the ventilation system for the laboratory and the containment building.

All fresh air for both the laboratory and the containment building enters through dampers on the north and south faces of the east tower and through the dampers of each RTAH unit. Fresh air entering through the north and south dampers passes into receiving plenums and through steam preheat coils.

The fresh air then passes through a dust filter, moving on through supply fan No. 1, (SF-1) heating and cooling coils, and finally into the double duct air distribution system.

Fresh air from the north and south RTAH's passes through chill water coils for air conditioning and secondary system reactor waste heat coils for heating, and is distributed via ceiling grills in the north and south corridors. Fresh air for the containment building passes up from the receiving plenum and is mixed with containment building return air. Containment building return air, driven by return fan RF-2, enters the east tower through the motorized isolation door No. 505. The mixed return plus fresh air passes through a dust filter, cooling coils, heating coils, and motorized isolation door No. 504 to supply fan SF-2. From supply fan (SF-2) the air is distributed throughout the containment building.

Laboratory building air and containment building air are never mixed. The supply and return fan pairs are interlocked so that if SF-2 is off, so is RF-2, however, RF-2 may be off with SF-2 on. If either of the motorized isolation doors (504 or 505) are closed, SF-2 and RF-2 are both off.

Exhaust air from both the containment and the laboratory building enters the atmosphere through either exhaust fan EF-13 or 14 and then through the exhaust stack located in the west tower. Either one or the other (EF-13 or EF-14) exhaust fan is on at all times. The other fan is a standby. Failure of the on-line fan automatically activates the standby and also activates a warning light in: (a) the reactor control room; and (b) in the facility lobby. Failure of both fans activates an alarm buzzer only in Reactor control room.

Laboratory exhaust air is picked up at the fume hoods, passed through absolute filters, and delivered to EF-13 or 14. Exhaust air from the mechanical equipment room is delivered to EF-13 or 14 through activated charcoal and absolute filters.

Containment building exhaust air enters EF-13 or 14 through two (2) quick-closing isolation valves. This exhaust air is picked up from beamport experiments storage ports, beamports, the thermal column, the Nuclepore film shield box, and the pool surface air sweep.

7. Hazards Summary Report, Addendum 3, Section 2.3, Page 20, Figure 2.2

   Delete original Figure 2.2 and replace with new Figure 2.2. This drawing was revised to reflect improvements in the air conditioning system and removal of a Chromate mixing tank.

8. Hazard Summary Report, Addendum 3, section 2.4 Figure 2.3

   Delete original Figure 2.3 and replace with updated Figure 2.3.

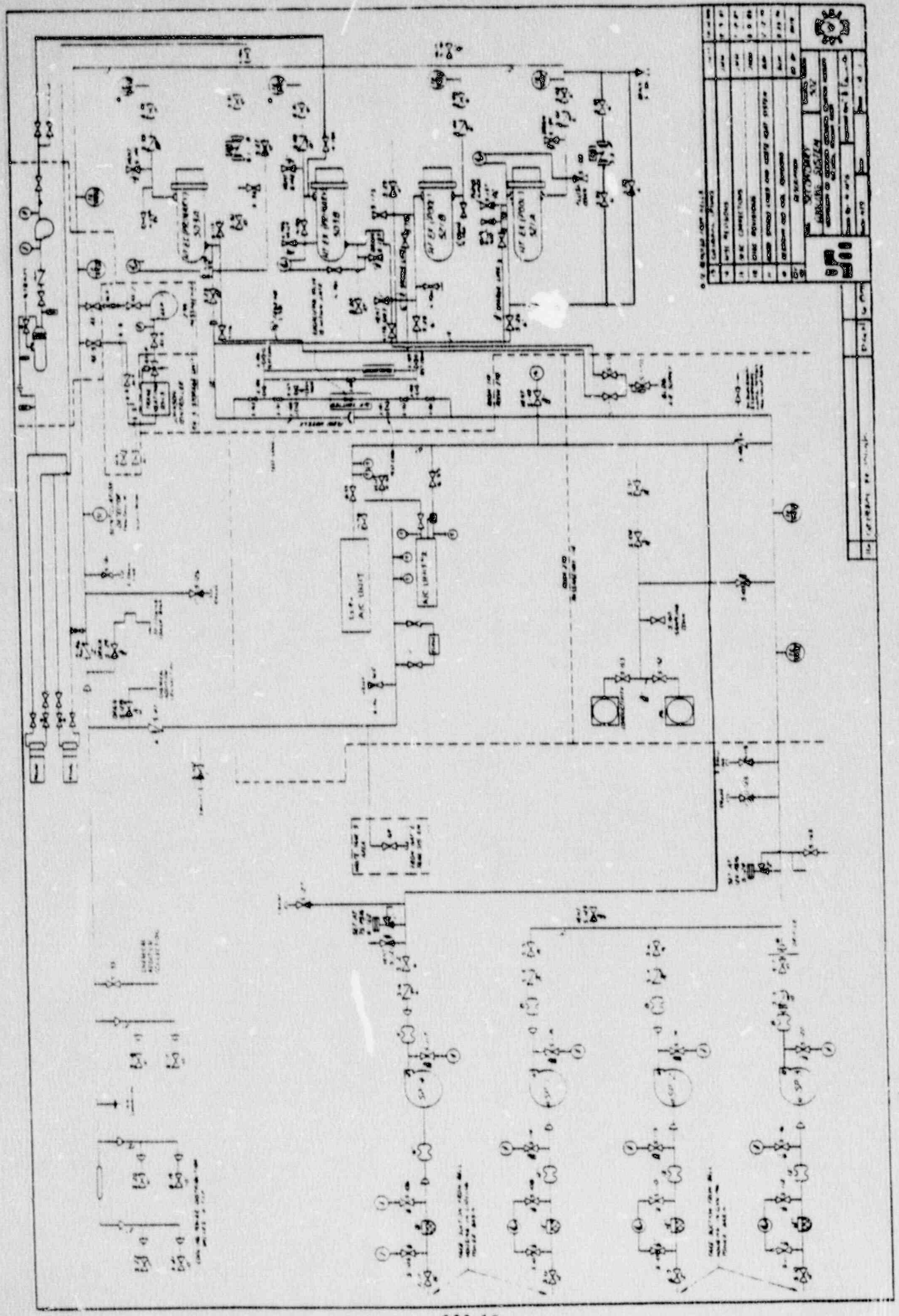


Figure 2.2

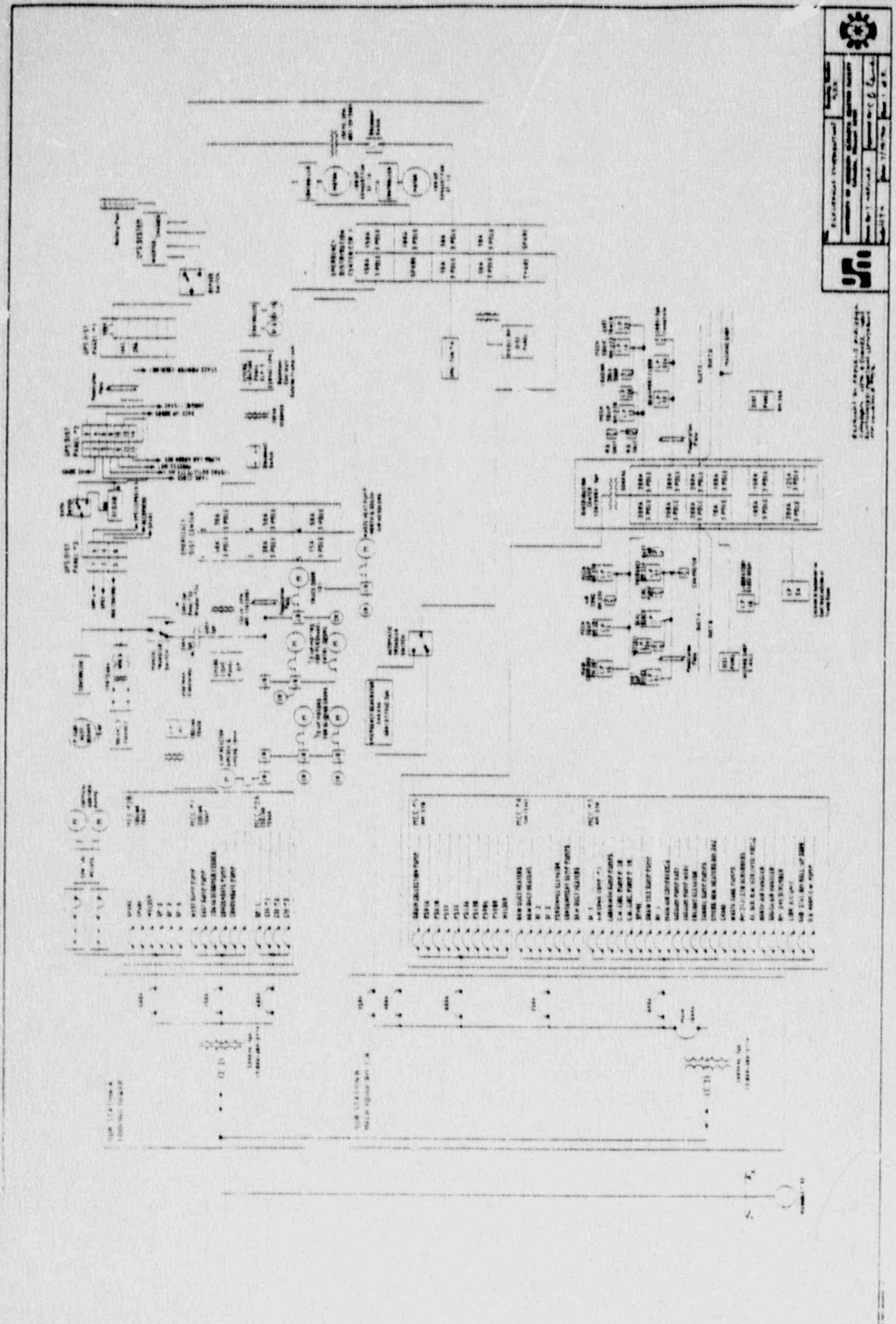


Figure 2.3

1

IMAGE EVALUATION
TEST TARGET (MT-3)

150mm

6"

9. Hazards Summary Report, Addendum 3, Section 5.3 Effluents (pp. 193-194)

Add new Section 5.3.3

EVALUATION OF ENVIRONMENTAL IMPACT OF INCREASED STACK RELEASE FLOW RATE.
(see attachment, pp. A1-A18)

EVALUATION OF ENVIRONMENTAL IMPACT

OF INCREASED STACK RELEASE FLOW RATE

Stack release limits set for MURR in Technical Specification[1] Number 3.7: "Facility Gaseous and Particulate Radioactive Release" are based on activity concentrations. An increase in stack flow rate affects the total allowable release of activity, and thus this evaluation is made to assess the environmental impact the increase will have on the nearest resident and on the population surrounding the MURR. The change in stack height and exhaust exit path is also considered. The safety significance of the impact is discussed in relation to background radiation and in relation to a previous environmental impact appraisal made by NRC.[2]

Data and Assumptions

The data and calculations in Table 1 describe the physical information of the stack release point. Argon-41 is the principal isotope released in gaseous effluents from MURR. The Technical Specification limit for Ar-41 release is 350 times the MPC listed in Appendix B, Table II, Column I of 10CFR20, or:

$$
\begin{aligned}
Q &= 350 \times \text{MPC} \times \text{flowrate} \\
&= (350)(4\times10^{-8}\mu\text{Ci/ml})(36500\ \text{ft}^3/\text{min})(2.831 \times 10^4\text{ml/ft}^3) \\
&= (1.4 \times 10^4\ \mu\text{Ci/min})(1\times10^{-6}\ \text{Ci}/\mu\text{Ci})(1\ \text{min}/60\text{sec}) \\
&= 2.4 \times 10^{-4}\ \text{Ci/sec}
\end{aligned}
$$

In the previous environmental assessment,[2] the NRC used meteorological data collected at the Callaway Plant, located near Fulton. These data were collected between May 5, 1973 and May 4, 1975, and were judged by the NRC to be "reasonably representative of long-term conditions expected at the MURR site." This current assessment utilizes meteorological data gathered in Columbia, MO from 1960 to 1969.[3] The Columbia data was judged to be more appropriate for use in assessing airborne releases from MURR because of the longer data period and the proximity of the data site to MURR. Table 2 lists wind data (stability, class, speed and frequency) for each of the sixteen campus points.

Table 1

Physical Information for Stack Release Point

Elevation above sea level = 687 feet

Diameter = 40 inches

New Max flowrate = 36500 ft^3/min

Area Cross Section = πr^2

$$= \pi \left(\frac{40 \text{ inches}}{2 \cdot 12 \text{ inches/ft}} \right)^2$$

$$= 8.73 \text{ ft}^2$$

$$\text{Air Velocity (V)} = \frac{36500 \text{ ft}^3/\text{min}}{8.73 \text{ ft}^2} \cdot 0.304 \text{ m/ft} \cdot \frac{1 \text{ min}}{60 \text{ sec}}$$

$$= 21.2 \text{ m/sec}$$

TABLE 2

Meteorological Data--Columbia, MO (1960-1969)[3]

Stability class information NNE

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% NNE[d] wind	%'s[e] comb.
A	0.4	2.[illegible]	3.4	1.4e-04
B	4.7	2.3	2.7	1.3e-03
C	11.5	4.0	3.5	4.0e-03
D	53.6	5.7	4.2	2.3e-02
E	17.6	3.8	3.2	5.6e-03
F	12.2	2.4	4.9	6.0e-03

Stability class information NE

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% NE[d] wind	%'s[e] comb.
A	0.4	2.1	1.7	6.8e-05
B	4.7	2.7	2.6	1.2e-03
C	11.5	3.7	2.7	3.1e-03
D	53.6	5.2	3.9	2.1e-02
E	17.6	3.6	2.8	4.9e-03
F	12.2	2.5	4.9	6.0e-03

Stability class information ENE

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% ENE[d] wind	%'s[e] comb.
A	0.4	2.0	7.8	3.1e-04
B	4.7	2.8	5.1	2.4e-03
C	11.5	3.9	4.3	4.9e-03
D	53.6	4.9	4.7	2.5e-02
E	17.6	3.4	4.2	7.4e-03
F	12.2	2.5	6.8	8.3e-03

Stability class information **E**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% E[d] wind	%'s[e] comb.
A	0.4	2.0	4.3	1.7e-04
B	4.7	2.9	5.3	2.5e-03
C	11.5	3.8	4.4	5.1e-03
D	53.6	4.9	4.4	2.4e-02
E	17.6	3.5	5.0	8.8e-03
F	12.2	2.5	7.9	9.6e-03

Stability class information **ESE**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% ESE[d] wind	%'s[e] comb.
A	0.4	2.0	3.4	1.4e-04
B	4.7	2.9	4.7	2.2e-03
C	11.5	3.9	4.8	5.5e-03
D	53.6	5.3	6.1	3.3e-02
E	17.6	4.0	6.1	1.1e-02
F	12.2	2.6	4.5	5.5e-03

Stability class information **SE**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% SE[d] wind	%'s[e] comb.
A	0.4	2.2	2.6	1.0e-04
B	4.7	2.9	4.6	2.2e-03
C	11.5	4.1	6.4	7.4e-03
D	53.6	5.7	7.8	4.2e-02
E	17.6	4.1	8.2	1.4e-02
F	12.2	2.5	4.3	5.2e-03

Stability class information

SSE

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% SSE[d] wind	%'s[e] comb.
A	0.4	2.3	4.3	1.7e-04
B	4.7	3.0	6.5	3.1e-03
C	11.5	4.1	8.7	1.0e-02
D	53.6	5.6	9.3	5.0e-02
E	17.6	4.1	12.0	2.1e-02
F	12.2	2.7	7.2	8.8e-03

Stability class information **S**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% S[d] wind	%'s[e] comb.
A	0.4	2.1	6.0	2.4e-04
B	4.7	3.0	10.8	5.1e-03
C	11.5	4.2	14.4	1.7e-02
D	53.6	5.6	11.8	6.3e-02
E	17.6	4.0	17.6	3.1e-02
F	12.2	2.6	12.0	1.5e-02

Stability class information **SSW**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% SSW[d] wind	%'s[e] comb.
A	0.4	2.4	6.0	2.4e-04
B	4.7	3.1	8.6	4.0e-03
C	11.5	4.1	9.7	1.1e-02
D	53.6	5.6	5.5	2.9e-02
E	17.6	3.9	7.4	1.3e-02
F	12.2	2.6	6.3	7.7e-03

Stability class information **SW**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% SW[d] wind	%'s[e] comb.
A	0.4	1.8	5.2	2.1e-04
B	4.7	3.0	9.2	4.3e-03
C	11.5	4.1	7.5	8.6e-03
D	53.6	5.4	3.5	1.9e-02
E	17.6	3.9	4.3	7.6e-03
F	12.2	2.5	6.0	7.3e-03

Stability class information **WSW**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% WSW[d] wind	%'s[e] comb.
A	0.4	2.2	6.0	2.4e-04
B	4.7	3.0	10.8	5.1e-03
C	11.5	4.3	9.0	1.0e-02
D	53.6	5.9	4.9	2.6e-02
E	17.6	3.9	5.7	1.0e-02
F	12.2	2.5	5.9	7.2e-03

Stability class information **W**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% W[d] wind	%'s[e] comb.
A	0.4	1.8	3.4	1.4e-04
B	4.7	2.8	6.7	3.1e-03
C	11.5	3.9	6.2	7.1e-03
D	53.6	6.0	4.7	2.5e-02
E	17.6	3.7	5.3	9.3e-03
F	12.2	2.5	6.1	7.4e-03

Stability class information WNW

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% WNW[d] wind	%'s[e] comb.
A	0.4	2.1	4.3	1.7e-04
B	4.7	2.8	5.4	2.5e-03
C	11.5	4.3	5.1	5.9e-03
D	53.6	6.7	7.9	4.2e-02
E	17.6	4.0	5.5	9.7e-03
F	12.2	2.5	5.0	6.1e-03

Stability class information NW

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% NW[d] wind	%'s[e] comb.
A	0.4	2.2	4.3	1.7e-04
B	4.7	2.[illegible]	4.4	2.1e-03
C	11.5	[illegible]	4.7	5.4e-03
D	53.6	7.1	8.8	4.7e-02
E	17.6	4.2	5.1	9.0e-03
F	12.2	2.5	3.6	4.4e-03

Stability class information NNW

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% NNW[d] wind	%'s[e] comb.
A	0.4	2.3	1.7	6.8e-05
B	4.7	2.7	2.9	1.4e-03
C	11.5	4.1	3.0	3.5e-03
D	53.6	6.6	5.8	3.1e-02
E	17.6	4.0	3.6	6.3e-03
F	12.2	2.4	3.0	3.7e-03

Stability class information **N**

Class[a]	% Class[b]	Wind speed[c] (m/sec)	% N[d] wind	%'s[e] comb.
A	0.4	2.4	7.8	3.1e-04
B	4.7	2.7	4.8	2.3e-03
C	11.5	4.0	4.8	5.5e-03
D	53.6	6.0	6.2	3.3e-02
E	17.6	3.8	4.0	7.0e-02
F	12.2	2.5	5.8	7.1e-03

[a] Stability class as defined by Pasquill's Categories.[4]

[b] Annual frequency distribution of stability class for all directions, or the total probability of occurrence for that class.

[c] Average wind speed for stability class and wind direction.

[d] Annual frequency distribution of wind direction for the specific stability class, or the probability of the wind direction given that the stability class exists.

[e] %'s comb. = (% class/100) x (% NNE/100), or the joint probability of the specific stability class and the specific direction occurring at the same time.
Example: A conditional probability is one in which the probability of the events depends upon whether the other event has occurred.[5]
P(A) = probability of Class A conditions = 0.4%.
P(N/A) = probability of wind direction from N given Class A conditions = 7.8%.
P(AN) = probability of having Class A conditions and wind direction from N.
P(AN) = P(A) P(N/A) = 3.1×10^{-4}.

Listed in Table 3 are the equations used to calculate the Ar-41 concentration and dose, along with the associated assumptions used for each case, at a distance, x, downwind from the stack release point. Calculations are based on the Pasquill-Gifford Method of determining stack release concentrations (effective stack height). Data for σ_y and σ_z were obtained from Ref. 4 and the DCF from Ref. 6.

Table 3

Equations and Assumptions

(1) Effective Stack Height[4] (H):

$$H = h + d\left(\frac{v}{\mu}\right)^{1.4}\left(1 + \frac{\Delta T}{T}\right) \qquad \text{(Eq. 1)}$$

where, h = actual height (m)
= difference in elevation from release point to downwind site of dose calculation
d = diameter of release point (m)
μ = average wind speed for specific stability class (m/sec)
v = exit velocity (m/sec)
ΔT = temperature difference between stack air and surrounding air
= assumed to be 0
T = absolute temperature of stack air

Therefore,

$$H = h + d\left(\frac{v}{\mu}\right)^{1.4} \quad . \qquad \text{(Eq. 1a)}$$

(2) Concentration Calculation:

$$\frac{\chi}{Q} = \frac{1}{\pi\sigma_y\sigma_z\mu}\exp\left[-\frac{1}{2}\left(\frac{y^2}{\sigma_y^2} + \frac{H^2}{\sigma_z^2}\right)\right] \qquad \text{(Eq. 2)}$$

where, χ = concentration at downwind site of dose calculation (μCi/ml or Ci/m^3)
Q = release rate (Ci/sec)
σ_y = lateral dispersion coefficient at downwind site of dose calculation (m)
σ_z = vertical dispersion coefficient at downwind site of dose calculation for specific stability class (m)
μ = average wind speed for specific stability class (m/sec)
y = distance from plume centerline (m) for maximum concentration, assume to be 0
H = effective stack height (m)

For maximum concentration:

$$\frac{\chi}{Q} = \frac{1}{\pi\sigma_y\sigma_z\mu} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] \quad . \qquad \text{(Eq. 2a)}$$

Further, for case of ground release (H=0),

$$\frac{\chi}{Q} = \frac{1}{\pi\sigma_y\sigma_z\mu} \quad . \qquad \text{(Eq. 2b)}$$

Considering decay, the equation becomes

$$\frac{\chi}{Q} = \frac{e^{-\lambda t}}{\pi\sigma_y\sigma_z\mu} \qquad \text{(Eq. 2c)}$$

where, λ = decay constant for Ar-41 (sec^{-1})
t = time (sec)
= x/μ

(3) Annual Dose Calculation (D):

$$D = DCF \sum_i \chi_i \ (\%\ comb)_i \qquad \text{(Eq. 3)}$$

where, DCF = dose conversion factor
= 8.84×10^{-3} $\frac{mrem\ m^3}{pCi\text{-}y}$ for Ar-41[6]
i = summation over all stability classes
$(\%\ comb)_i$ = relative frequency for stability class, i, and specific wind direction

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Maximum Individual Dose

To determine the maximum individual dose, the south wind direction was chosen as being the most probable and annual doses determined at maximum release rate for two different distances: 150 m north to the exclusion boundary,[7] and 760 m north to the nearest residence. Elevations for these two sites were estimated from a University of Missouri topographical map (shown in Fig. 1). Data and the maximum calculated dose estimates for these sites are given in Table 4, with an example calculation given in Table 5. The maximum average annual dose at 150 m was calculated as ~ 2 mrem/y and ~ 18 mrem/y and at 760 m. The difference in relative plume height at these sites is what leads to this difference in dose rates.

Table 4

Maximum Average Annual Individual Dose

Location at 150 m Directly North

Elevation at man height: 636 ft.

Class	Eff height (m)	σ_y (m)	σ_z (m)	χ/Q (s/m^3)	χ ($\mu Ci/ml$) (Ci/m^3)	Dose w/%'s (mrem/y)
A	42	35	23	3.6e-05	8.6e-09	0.0
B	31	25	15	3.3e-05	7.9e-09	0.4
C	25	19	11	2.5e-05	6.0e-09	0.9
D	22	12	7	4.5e-06	1.1e-09	0.6
E	26	9	5	1.9e-09	4.6e-13	0.0
F	35	6.6	3.2	2.7e-28	6.5e-32	0.0
					TOTAL	1.9 mrem/y

Location at 760 m. directly North.
Elevation at man height: 700 ft.

Class	Eff height (m)	σ_y (m)	σ_z (m)	χ/Q (s/m^3)	χ ($\mu Ci/ml$) (Ci/m^3)	Dose w/%'s (mrem/y)
A	23	160	300	3.2e-06	7.8e-10	0.0
B	12	110	90	1.1e-05	2.5e-09	0.1
C	6	81	50	1.9e-05	4.5e-09	0.7
D	3	54	25	4.2e-05	1.0e-08	5.7
E	7	41	18	1.0e-04	2.5e-08	6.7
F	15	30	11	1.4e-04	3.5e-08	4.5
					TOTAL	17.7 mrem/y

Table 5

Example Calculation

Distance: 760 m North
Elevation: 700 ft.
Class E: $\mu = 4.0$ m/sec
$\sigma_y = 41$ m
$\sigma_z = 18$ m

Effective Stack Height:

$$H = 687 + \left(\frac{40}{12}\right)\left(\frac{21.2}{4.0}\right)^{1.4} - 700$$

$$= 21 \text{ ft} \cdot \frac{1\text{m}}{3.2808 \text{ ft}}$$

$$= 6.5 \text{ m}$$

Ar-41 Concentration:

$$\frac{\chi}{Q} = \frac{1}{\pi(41)(18)(4)} \exp\left[-\frac{1}{2}\left(\frac{6.5}{18}\right)^2\right]$$

$$= (1.08 \times 10^{-4})(0.94)$$

$$= 1.0 \times 10^{-4} \frac{\text{sec}}{\text{m}^3}$$

$$\chi = \left(1.0 \times 10^{-4} \frac{\text{sec}}{\text{m}^3}\right)(2.4 \times 10^{-4} \text{Ci/sec})$$

$$= 2.4 \times 10^{-8} \frac{\text{Ci}}{\text{m}^3}$$

$$= 2.4 \times 10^{-8} \frac{\mu\text{Ci}}{\text{ml}}$$

Class E occurs 17.6% of the time and of that time the wind blows from the South 17.6% of time.

$$\text{%'s comb} = \left(\frac{17.6}{100}\right)\left(\frac{17.6}{100}\right) = 0.031$$

$$\text{Dose}_E = \left(2.4 \times 10^{-8} \frac{\text{Ci}}{\text{m}^3}\right) 0.031 \left(8.84 \times 10^{-3} \frac{\text{mrem-m}^3}{\text{pCi y}}\right)\left(10^{12} \frac{\text{pCi}}{\text{Ci}}\right)$$

$$= 6.7 \text{ mrem/y}$$

Maximum Population Dose Estimate

Population dose estimates were made assuming ground release conditions. Population density data was generated[8] using 1980 census data, 1985 update data, and growth projections provided by City of Columbia officials. Estimates for population doses were based on the projected 1990 population densities (See Table 6).

The maximum average annual dose was determined at the center of each population zone, except for the 16 zones at 0-1 miles. Because residences are no closer than 760 m, the midpoint was chosen at 0.75 miles (1200 m) from MURR. In addition, radioactive decay was considered in these calculations due to the significant amount of time required for the plume to move to these distances. Otherwise, calculations were made as were the individual dose estimate calculations. Data for σ_y and σ_z is given in Table 7, the summary of annual doses in Table 8, and the population dose estimate in Table 9. For the population out to 10 miles, the maximum annual popula-tion dose is estimated to be 145 person-rem.

Table 6

Projected 1990 Population Densities
(Number of People)

Wind Direction	Midpoint Distances (m) 1200	2400	4000	5600	7200	12000
NNE	238	437	368	315	262	206
NE	101	845	469	105	210	204
ENE	132	534	449	440	76	305
E	94	1189	1270	3905	220	315
ESE	186	1138	2025	849	51	3850
SE	406	2096	1664	1021	474	402
SSE	354	2747	1676	542	428	920
S	364	2649	2293	644	157	5750
SSW	1131	3163	1843	1404	1513	6135
SW	2699	5137	2491	2387	1571	2877
WSW	1997	4803	1067	1146	1055	5610
W	49	1446	525	385	153	234
WNW	52	592	1182	325	364	316
NW	36	126	644	222	103	315
NNW	288	665	229	30	154	210
N	339	851	974	432	210	255

TABLE 7

σ_y's (top) and σ_z's (bottom) for

population distances and stability

Stability Class	Midpoint Distances (m) 1200	2400	4000	5600	7200	12000
A	220 800	400 5000	620 9700	900 14000	1050 19000	1800 33000
B	170 150	310 470	480 1100	690 2200	820 3300	1300 6600
C	130 75	220 130	340 200	480 270	600 320	900 500
D	80 34	140 53	220 72	300 91	400 100	610 140
E	60 23	110 40	170 50	220 60	300 70	460 84
F	42 14	80 22	120 30	160 33	200 40	300 48

TABLE 8

A Summary of dose rate estimates (mrem/y)

based on wind direction & distance

Wind Direction	Midpoint Distances (m) 1200	2400	4000	5600	7200	12000
NNE	4.5	1.4	0.7	0.4	0.3	0.1
NE	4.3	1.4	0.6	0.4	0.2	0.1
ENE	6.1	2.0	0.9	0.6	0.3	0.2
E	6.7	2.1	1.0	0.6	0.4	0.2
ESE	5.2	1.7	0.8	0.5	0.3	0.1
SE	5.9	1.9	0.9	0.5	0.3	0.2
SSE	8.4	2.7	1.3	0.8	0.5	0.2
S	13.0	4.2	1.9	1.2	0.7	0.3
SSW	6.3	2.0	0.9	0.6	0.4	0.2
SW	5.1	1.7	0.8	0.5	0.3	0.1
WSW	5.7	1.8	0.8	0.5	0.3	0.1
W	5.6	1.8	0.8	0.5	0.3	0.1
WNW	5.5	1.8	0.8	0.5	0.3	0.1
NW	4.7	1.5	0.7	0.4	0.3	0.1
NNW	3.7	1.2	0.6	0.3	0.2	0.1
N	5.5	1.8	0.8	0.5	0.3	0.1

TABLE 9

Person-Rem Estimates (person-rem/y)

Wind Direction	Midpoint Distances (m) 1200	2400	4000	5600	7200	12000
NNE	1.1	0.6	0.2	0.1	0.1	0.0
NE	0.4	1.2	0.3	0.0	0.1	0.0
ENE	0.8	1.0	0.4	0.2	0.0	0.0
E	0.6	2.5	1.3	2.4	0.1	0.1
ESE	1.0	1.9	1.6	0.4	0.0	0.5
SE	2.4	4.0	1.5	0.6	0.2	0.1
SSE	3.0	7.5	2.1	0.4	0.2	0.2
S	4.7	11.1	4.5	0.8	0.1	1.9
SSW	7.2	6.5	1.7	0.8	0.5	1.0
SW	13.9	8.5	1.9	1.1	0.5	0.4
WSW	11.3	8.7	0.9	0.6	0.3	0.8
W	0.3	2.6	0.4	0.2	0.0	0.0
WNW	0.3	1.1	1.0	0.2	0.1	0.0
NW	0.2	0.2	0.5	0.1	0.0	0.0
NNW	1.1	0.8	0.1	0.0	0.0	0.0
N	1.8	1.5	0.8	0.2	0.1	0.0
Subtotals	50.0	59.8	19.2	8.2	2.4	5.3
					TOTAL	144.8

Consideration of Normal Operational Releases

For the past five years, MURR has released ~ 1000 Ci/y of Ar-41 with a stack flowrate of ~ 16,500 ft^3/min. Production of Ar-41 is expected to remain the same, and so the average Ar-41 concentration is anticipated to be:

$$3.7E-6(\mu Ci/ml) \cdot 16500/36500 = 2E-6\ \mu Ci/ml$$

which is ~ 13% of the Technical Specifications Limit. Because the dose estimates calculated thus far are proportional to the total amount of Ar-41 released, the dose estimates for actual operating conditions are easily calculated using the ratios of the stack release flow rates (given Ar-41 production remains constant). The actual operational dose estimates are:

Individual @ 150 m = 0.2 mrem/y
Individual @ 760 m = 2 mrem/yr
Population to 10 miles = 15 person-rem

Comparison of Risk

In the Safety Evaluation made by the NRC in support of Amendment No. 12,[2] an individual located at the nearest residence was estimated to receive an annual average total body dose of 13 mrem per year based on the 1977/78 release of 1925 Ci/y and 29 mrem/y for the maximum estimate. In the same NRC evaluation, the population dose for implementing Amendment No. 12 was estimated to be 20 person-rem. Although assumptions, data, and conditions for calculation are not fully described in the NRC Amendment No. 12, estimated doses are greater than those predicted by the current assessment, which utilizes more realistic model (effective stack height and stability class weighting) and better site-specific data (meteorological data and updated population densities). The NRC concluded "that there would be no significant environmental impact attributable" to an increase in stack release limit to 350 MPC. With lower doses estimated for the current change in stack height and flowrate, it is also concluded that no significant environmental impact exists. The same conclusion applies to instantaneous release limits.

Another method of assessing risk from the estimated doses is to compare them to natural background dose rates. The average whole body dose to an individual in the US is 360 mrem/y.[9] The estimated doses in terms of % of natural background are:

	Maximum Case	Normal Operation
Individual @ 150 m	0.5%	0.1%
Individual @ 750 m	5%	0.6%
Population	0.4%	<0.1%

Variations of this magnitude can be found in annual dose for populations living in different areas of the US with no observable effects.

Conclusion

The estimated dose rates calculated using improved methods and data were no greater than those calculated from previous appraisals where impact was judged by the NRC to be not significant in environmental impact. Therefore, there is no significant reduction in safety as the result of the changes in the MURR stack release conditions.

References

(1) Appendix A: Technical Specifications for University of Missouri Research Reactor Facility--Facility Operating License No. R-103.

(2) NRC Amendment No. 12 for R-103, July 5, 1979.

(3) Callaway Environmental Report, Operational License Stage, Vol. 1, Tables 2.3-19 and 2.3-20.

(4) Cember, Herman, Introduction to Health Physics, Second Edition, Pergamon Press, 1983, pp. 340-352.

(5) DeGroot, Morris H., Probability and Statistics, Addison-Wesley Publishing Company, Inc., 1975, pp. 49-50.

(6) Regulatory Guide 1.109: "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

(7) NRC Amendment No. 8 for R-103, February 24, 1978.

(8) Environmental Report for Upgrade of MURR, 1987 (Draft).

(9) NCRP Report No. 94: "Exposure of the Population in the United States and Canada from Natural Background Radiation," December 1987.

10. Hazard Summary Report, Addendum 5. Section 2.0 and Figure 2.1

Delete original Section 2.0 (pp. 2-14 and Figure 2.1) and replace with the following:

SECTION 2.0 ANALYSIS OF A LOSS OF ELECTRICAL POWER TO THE MURR

2.1 Introduction

This report contains an analysis of a complete loss of power at the MURR. This implies a loss of commercial power followed by a failure of the emergency generator system. The emergency generator system is described and the routine surveillance tests are outlined. Accident analyses will then be presented for a complete loss of electrical power during a period when the reactor is shut down.

2.2 Description

Upon a loss of normal electrical power to the facility, the EG assumes the desired electrical loads. Drive power to the generator is provided by a Cummins, six cylinder, turbocharged diesel engine. The engine is provided with a 270 gallon fuel storage tank and a mechanically driven fuel injection system. The EG is capable of assuming full load from a cold start in seven seconds. A 24 volt nickel-cadmium storage battery is used to start the EG. A static type dual rate float/equalizer charger automatically maintains the startup battery fully charged.

A four pole generator equipped with a brushless permanent magnet exciter produces 60 cycle, 277/480 volt, 3-phase service, and has a standby continuous load capacity of 275 KW. The design of the exciter and regulator provides voltage regulation of better than plus or minus 2%. Stable generator output voltage and frequency are established within two seconds after a transition from no load to full load conditions.

An automatic transfer switch (ATS) selects the power source for the emergency electrical loads from one of the two inputs:

1) Commercial Power
   (i) City Power Plant, or
   (ii) University Power Plant
(2) Emergency Generator Power

During normal operation, all loads are supplied from commercial power. Whenever a commercial power failure occurs for greater than one second duration the engine starts, the automatic transfer switch functions, and the EG assumes the load. Commercial power must be restored for a full ten minutes before the transfer switch functions to transfer the load to commercial power.

The EG will continue to run five minutes after the load is transferred back to commercial power in order to cool down the engine.

The EG and engine are located in a building addition on the southwest corner of the laboratory building. The diesel generator room has local temperature controllers to maintain room temperature above 55°F. The EG starting system is designed to start the EG at temperatures as low as 32°F. The operation of the temperature controllers is checked every four hours by the operating staff during reactor operation.

The emergency bus is routed through the automatic transfer switch to an emergency distribution panel located on the wall in the north inner corridor of the laboratory building. This feed panel distributes power to the following circuits (see fig. 2.1.):

(1) Two circuits service reactor and laboratory exhaust fans EF-13 and EF-14 located in the west tower.

(2) One circuit services a 120 VAC distribution panel providing power for exit lights, stairway lights, fan failure alarm, intercommunication system, and the reactor evacuation and isolation alarms.

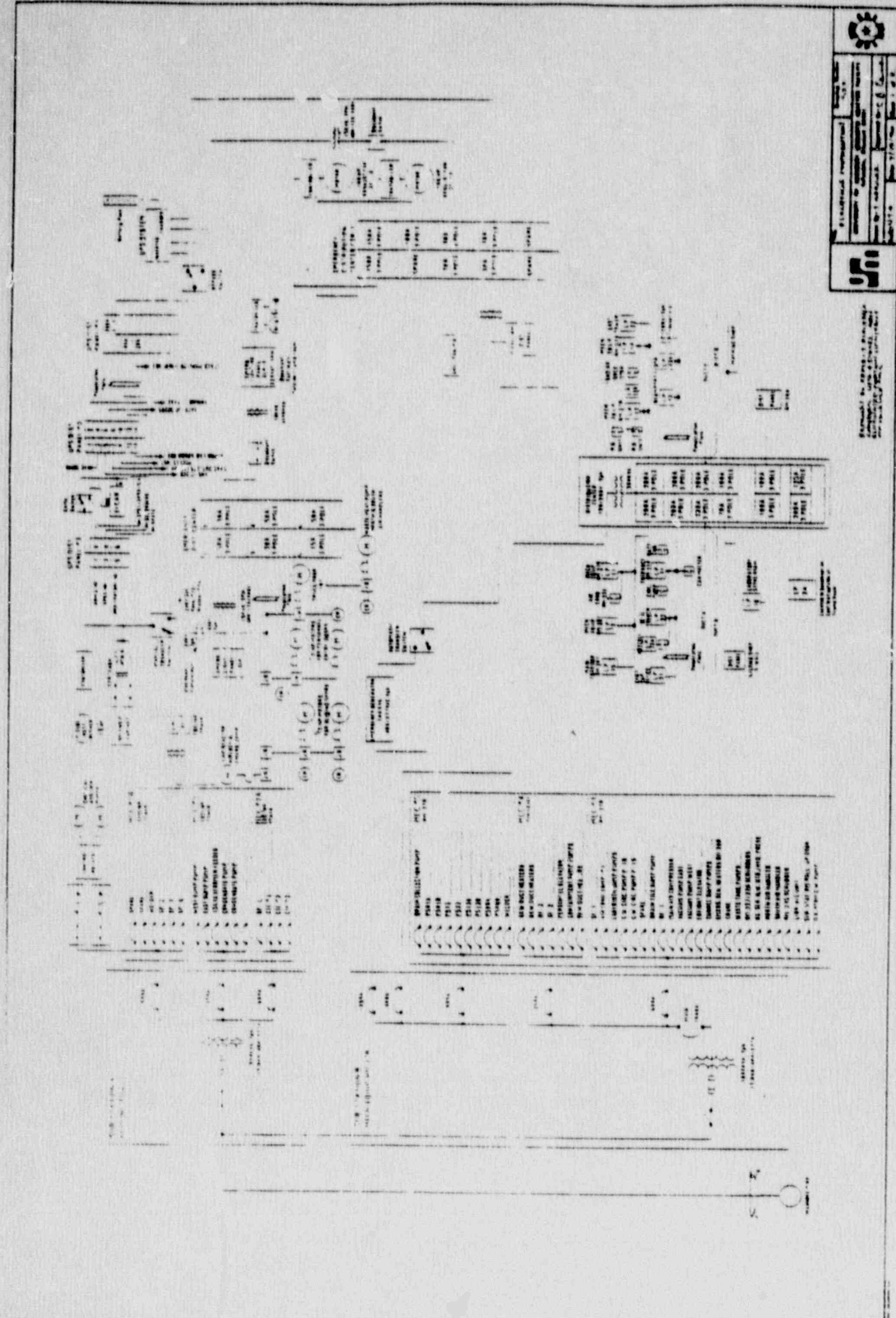


Figure 2.1

(3) One circuit services a 120 VAC distribution panel via either an uninterruptible power supply or line conditioner. This distribution panel provides power to the area radiation monitoring system, the annunciator control system, control room clock, all nuclear and process instrumentation in the control room, including control relay, solenoids, indications of primary, pool and other valve positions, control rod drives, rod run-in system, safety system and Servo amplifier system.

(4) One circuit provides power for the operation of the containment ventilation system isolation doors, emergency compressor, truck entry door, and personnel airlock doors.

2.3 <u>Surveillance Tests of Emergency Generator</u>

The EG and the Cummins diesel engine are tested routinely on the following basis:

(1) At least once a week the Cummins diesel engine which powers the generator is started and allowed to run for a period of thirty minutes without load.

(2) In addition, the Cummins diesel engine is started and run for thirty minutes prior to each reactor startup following a shutdown greater than twenty-four hours.

(3) The ability of the emergency electrical generator to assume the emergency load is verified on at least a semi-annual basis. Commercial power to the reactor facility is interrupted at the transfer switch, simulating a complete loss of commercial power to the reactor facility. This requires the EG to automatically start and assume full emergency electrical load.

(4) The entire unit is serviced routinely as part of a planned preventive maintenance program.

2.4 Accident Analysis

2.4.1 Loss of Commercial Power with the Reactor Operating at 10 MW and the Emergency Generator Fails to Start

Each system that is affected by a complete loss of electrical power is listed and commented upon in the following paragraphs.

(1) Reactor Control System

At the time of loss of commercial power while operating at 10 MW, the reactor would scram as a result of loss of power to the electromagnets holding the blades in position. The blades would drop into the core by gravitational force and the reactor would be shut down.

(2) Reactor Process System

All process systems (e.g., primary cooling, pool cooling, etc.) will be placed in the shutdown condition to the failsafe design of these systems. Loss of electrical power would cause a cessation of coolant flow and a closing of the isolation valves. In the primary system, redundant valves 546A and B open by spring actuation placing the in-pool heat exchanger in service. The failsafe design of the system permits shutdown decay heat removal with no electrical power (reference: Appendix D of Addendum 4 to Hazards Summary Report).

(3) Containment Building Ventilation Isolation Doors

Power would be lost to the motor operated doors and they would fail to close (or open) in response to any electrical signal. Also, the gasket seals would not inflate since the inflating mechanism responds only when the doors are closed against their stops. The backup isolation doors, however, fail closed upon loss of solenoid power and hence would automatically close upon loss of building power.

(4) Emergency Air Compressor

The emergency compressor motor would fail to operate in response to a falling pressure in the reserve tank. The reserve tank holds a volume of 10.5 ft^3 at a nominal pressure of 100 psi, which would be sufficient to inflate all gasket seals on all isolation doors if this were required. But the ability to recharge the tank to nominal operating pressure would be lost in the event of a complete power failure. The primary function of this compressor is to provide air to the seal gaskets of all isolation doors. Since the doors would not be operable with no power there is little demand for the emergency air supply.

(5) Truck Entry Door: Door 101 Beamhole Floor

During reactor operation and during periods when the reactor is left unattended, the door is closed and the seal is inflated. Loss of commercial power would prevent one from being able to open this door or deflate the seal. Hence, loss of commercial power during normal reactor operation would leave the status of this door unaffected.

(6) Personnel Airlock Door: Doors 275/276 Grade Level

During reactor operation and during periods when the reactor is left unattended, one of these doors remains closed and the gasket inflated. Loss of commercial power without the ability of the EG to provide emergency power, would prevent one from operating these doors electrically. There is in existence, however, a procedure by which the gaskets can be deflated manually and the doors manually opened or closed. Even though the doors cannot be operated electrically, it is possible for one to leave the building through these doors in the event of a power failure. However, the ability to maintain at least one door in the closed position with its seal gaskets inflated is lost if power to the doors is not available. The containment integrity of the building, therefore, cannot

be guaranteed if emergency and electrical power were not available to operate both doors. However, the reactor will be shutdown and containment is not a vital requirement.

(7) Laboratory and Reactor Exhaust Fans: EF-13 and EF-14, Fifth Level West Tower

Upon isolation of the reactor building, the operation or inoperation of these fans would have no consequence on the status of the reactor building. Upon loss of commercial building power without the availability of emergency power, both of these fans would cease to function.

(8) Reactor and Laboratory Corridor and Exit Lights

The 120-volt corridor and exit lights in both the reactor building and laboratory building depend upon commercial power or emergency backup. In most areas, emergency wall battery pack lights which operate upon loss of commercial building power provide sufficient lighting for all personnel to leave the reactor building and laboratory corridor areas safely. Visibility in all the strategic placement of these battery pack emergency lights.

(9) Fan Failure Alarm System

The exhaust fans, EF-13 and EF-14, "failure to operate" alarm system would not function. Loss of building commercial power and loss of emergency backup power would prevent the operation of these fans as previously discussed. Such a situation precludes the need for these alarms.

(10) Intercommunication System

The laboratory area and the reactor building are provided with a multiple station intercommunication system. The loss of this system results in the inability to transmit

messages rapidly to the entire facility. However, telephone communication to each laboratory area and various areas inside the reactor building would not be interrupted by a loss of commercial power. There is also provided portable battery-powered transmitter-receiver packs which can be used to maintain communication between the Emergency Director in the laboratory lobby and investigation parties sent out from that area.

(11) Reactor Building Isolation and General Evacuation Alarm

Loss of reactor building power without emergency back-up power would result in the loss of all audible and visual evacuation and isolation alarms.

(12) Diesel Room Distribution Panel

Power to the EG control panel, EG room lighting and EG room temperature controls are provided by this panel. Loss of commercial power as well as emergency power would leave these loads de-energized. However, failure of the generator engine to operate preempts the need for these loads.

(13) Reactor Controls and Instrumentation

Power to all reactor instrumentation and controls, both process and nuclear, is provided through a 120 VAC distribution panel located in the control room. Loss of commercial power without emergency backup would not effect the control and instrumentation power for 20 minutes because of the capacity of the uninterruptable power supply (UPS). Once the reactor is confirmed to be shutdown and before the UPS batteries reach a low voltage condition, the control and instrumentation systems would be secured. The UPS unit would be secured prior to the batteries reaching a low voltage condition to prevent a low voltage transient on the system. The reactor operators would then have no control console information relating to changes in the

status of reactor system different than that gathered when the UPS was operating.

All subsequent information regarding valve position and the status of the reactor would have to be obtained visually by the reactor operator. With the reactor shut down and with system status known before securing UPS power, the reactor operator can monitor valve position indications at the reactor bridge and the reduced intensity of the Cerenkov glow in the region of the core. Operation of the emergency pool fill system would be unaffected.

2.4.2 Loss of Electrical Power during Reactor Shutdown Periods

The status of all systems would be identical to that discussed in paragraph 2.4.1 with the following exceptions:

(1) Reactor Control System

In this case it can be assumed that the reactor is in the shutdown mode with all systems secured. This would be assured by the fact that prior to the loss of commercial power a complete shutdown checksheet for the reactor and systems had been completed. Therefore, there would be no need for the reactor operator to determine the status of the reactor or reactor systems after the loss of commercial power.

(2) Persons within Containment at the Time of Loss of Commercial Power

Research and other non-reactor staff personnel may be within the containment building at the time of the loss of commercial power. All personnel allowed un-escorted access to containment have a knowledge of how to operate the personnel airlock door manually without assistance at a time when electrical power to these doors is unavailable. Simple directions are posted next to the airlock doors.

(3) Containment of the Reactor Building

Containment integrity of the reactor building would be assured by virtue of the status of the reactor during a normal shutdown period. Truck entry door 101 on the beamhole floor would be closed and sealed, the 16" building exhaust isolation valves would have failed closed, the supply and return fan on the fifth level would have stopped operating, the primary isolation doors would remain open, however, the backup isolation doors would have failed closed.

2.5 Conclusions

Under the postulated failures, the reactor will shutdown and the core will be cooled indefinitely by natural convection circulation through the in-pool heat exchanger. It may be necessary to violate containment briefly to allow personnel to enter and exit containment, however, the reactor is in a safe configuration. Health Physics monitoring with portable instruments would preclude the accidental exposure of personnel to radiation.

SECTION IV

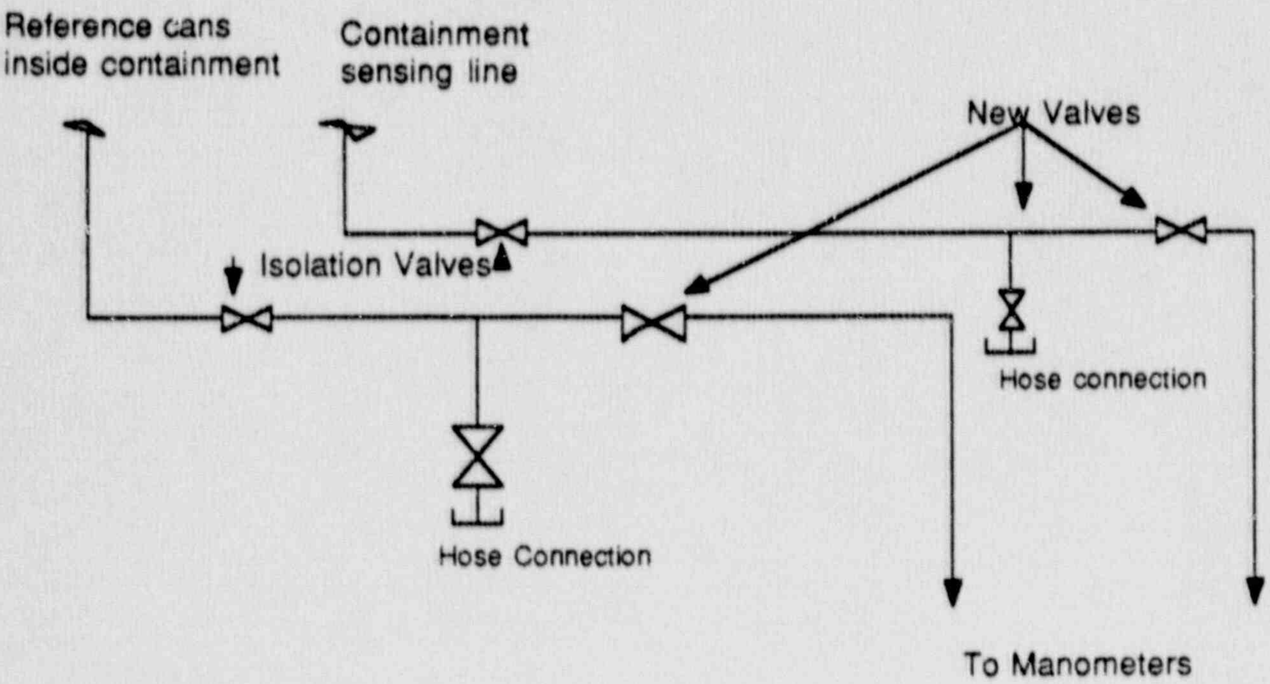
PLANT AND SYSTEM MODIFICATIONS
1 July 1989 through 30 June 1990

Modification 89-3: Containment Building and Air Sampling System

This modification provides a means for sampling containment building air from outside the containment building during a Reactor Isolation. The need for a means of remote sampling of the containment building (as opposed to having personnel enter into containment to sample) was recommended during a routine safety inspection by the Nuclear Regulatory Commission (NRC) on March 6-10, 1989.

This modification utilizes the system originally installed to perform the reference volume method of determining containment building leak rate. This system had not been used at MURR since 1978, when MURR changed its method of performing the building leak rate to the make-up flow method. The reference cans for the reference volume system have been disconnected to provide sampling points for the air sampling system (see Figures 1 & 2).

The safety evaluation for this modification documents that it does not present an unreviewed safety question as per 10 CFR 50.59.



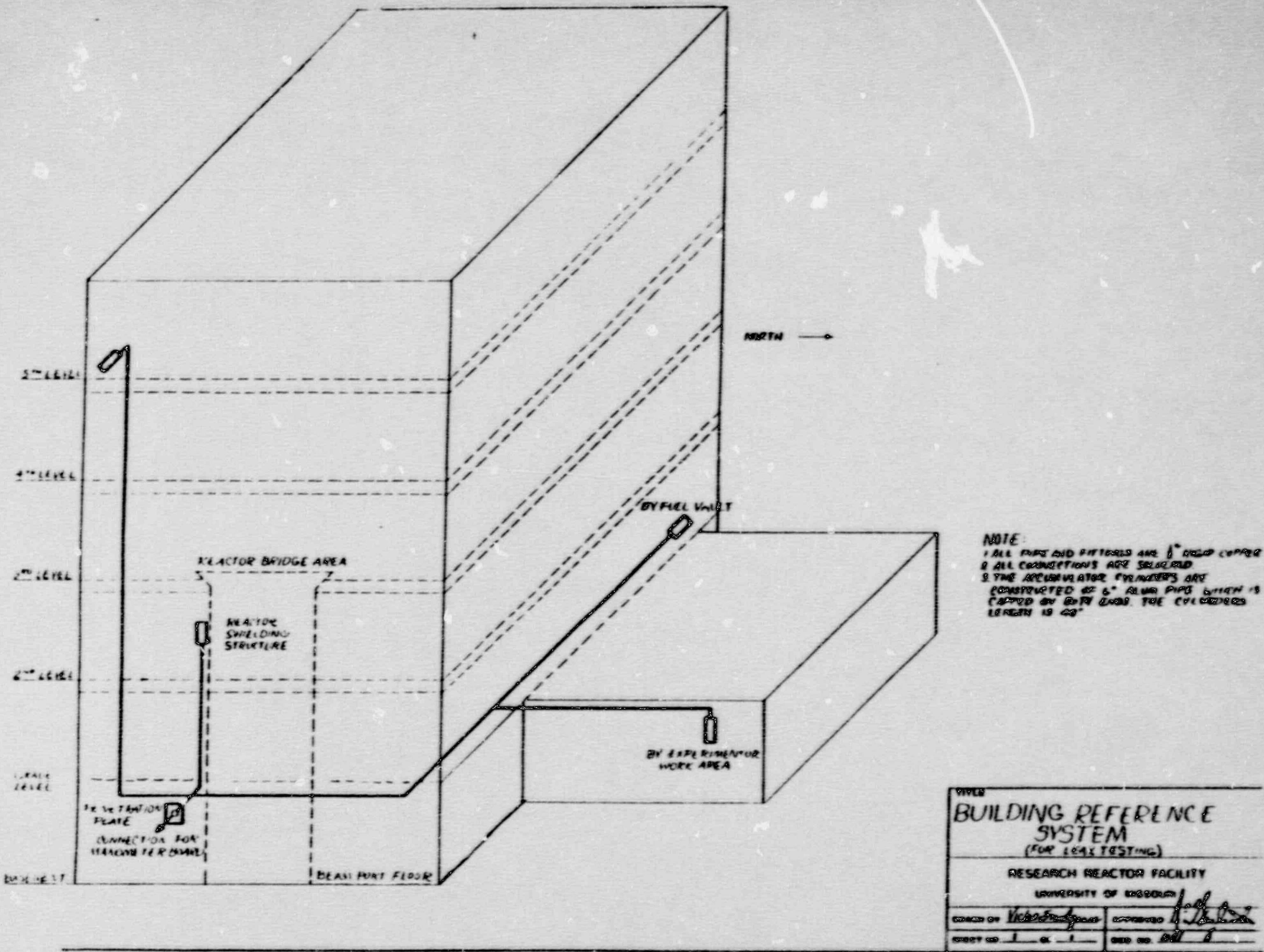

NORTH
BY FUEL VAULT
REACTOR BRIDGE AREA
REACTOR SHIELDING STRUCTURE
BY EXPERIMENTOR WORK AREA
BEAM PORT FLOOR
NOTE:
BUILDING REFERENCE SYSTEM
(FOR LEAK TESTING)
RESEARCH REACTOR FACILITY

Figure. 2

Modification 88-6: Emergency Electrical Power Upgrade (replacing emergency generator (EG) and automatic transfer switch)

This modification replaces the original 45 KW gasoline powered EG with a 275 KW, diesel powered generator. This change was made due to the age of the original EG as well as its lack of capacity for anticipated facility modifications. The HSR sections changed by this modification are mainly descriptions of the EG and the Emergency Electrical Distribution system. The HSR section (Addendum 5, Section 2.0) that contains an analysis of a complete loss of electrical power at MURR, remains virtually unchanged except for descriptions of the new EG and Emergency Distribution System. The surveillance tests for the new EG will be incorporated into the HSR and will meet or exceed technical specification requirements. The HSR Addendum 5, Section 2.0 analysis concludes that a complete loss of electrical power creates no hazard to the health or welfare of the general public. The bases for Technical Specification 3.10 states that on loss of normal electrical power the EG is not required for protection of the fuel element integrity.

The probability of the occurrence of a malfunction in the new EG is expected to be less than that of the original EG, which had provided 22 years of service, but had no capacity for future expansion of emergency electrical loads (i.e. new exhaust ventilation fans).

The safety evaluation for this modification, summarized here, documents that it does not present an unreviewed safety question as per 10 CFR 50.59.

Modification 88-11: Reactor Control Power Upgrade

This modification replaces the Elgar line conditioner with an Uninterruptible Power Supply (UPS) to provide regulated reactor control power. The replaced Elgar line conditioner was not specified in the original Hazard Summary Report. The line conditioner was added as an enhancement to the 120 VAC electrical supply to the reactor control and instrumentation power supplies.

HSR Addendum 1, Section 3.5 addresses the regulation required of MURR instrumentation and control and specifies system tolerances to electrical supply changes over the following ranges:

Supply Voltage:	115 Volt +/- 10%
Supply Frequency:	60 Hz +/- 5%
Temperature:	32°F to 120°F

These regulation parameters provided the impetus to install the Elgar line conditioner, which can regulate supply electrical power as follows:

Supply Voltage:	115 Volt +/- .05%
Supply Frequency:	60 Hz +/- .05%

The UPS can provide regulation as follows:

+/- 1% of Nominal Voltage (115 VAC)
+/- 0.1% of Nominal Frequency (60 Hz)

The UPS cannot provide the absolute voltage regulation of a line conditioner, but it provides regulation over a greater range of input voltages. A line conditioner regulates small monitoring voltage fluctuations, whereas a UPS regulates the output for even a complete loss of input voltage.

The UPS will protect the reactor instrumentation and control power from line transients, line noises and during the transitional period between the loss of facility electrical power and when the Emergency Generator assumes emergency loads (see fig 3). The safety evaluation for this modification, summarized here, documents that it does not present an unreviewed safety question as per 10 CFR 50.59.

Modification 88-7: Exhaust Ventilation Upgrade

This modification to the ventilation system replaces the original exhaust fans with two speed fans and 100 H.P.motors and adds an acid scrubbing system for the silicon laboratory to remove nitric, hydrofluoric and acetic acids. The new exhaust fans increase discharge flow from 20,500 SCFM to 33,500 SCFM, which ensures all MURR fume hoods will have a minimum of 125 LFM face velocity. These modifications also required the addition of two (2) new roof top air handlers (6,000 SCFM each) to supply air to the facility. Modifications to the fan failure and warning system have also been accomplished.

The fast speed isokinetic probes for the stack monitor were installed on May 7, 1990. The ventilation system was balanced on May 14, 1990 and placed in continuous fast speed operation on May 15, 1990.

This modification will be complete when the auxiliary heating system for the new roof top air handlers are modified and operationally checked.

The safety evaluation for this modification documents that it does not present an unreviewed safety question as per 10 CFR 50.59.

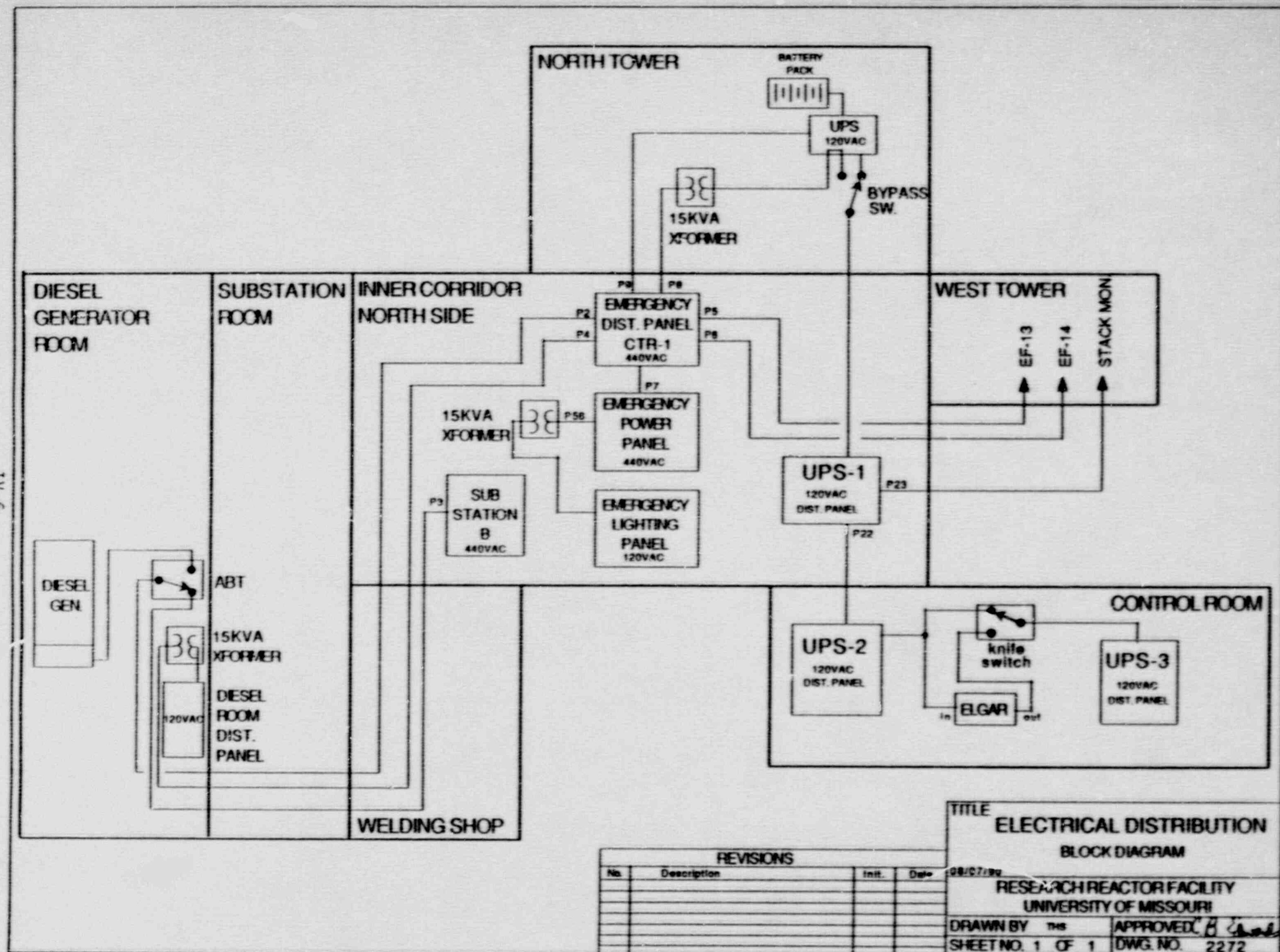

NORTH TOWER
BATTERY PACK
UPS
120VAC
BYPASS SW.
15KVA XFORMER
DIESEL GENERATOR ROOM
SUBSTATION ROOM
INNER CORRIDOR NORTH SIDE
WEST TOWER
P9
P8
P2
P4
P5
P6
EMERGENCY DIST. PANEL CTR-1 440VAC
P7
15KVA XFORMER
P56
EMERGENCY POWER PANEL 440VAC
EF-13
EF-14
STACK MON
UPS-1 120VAC DIST. PANEL
P23
P22
P3
SUB STATION B 440VAC
EMERGENCY LIGHTING PANEL 120VAC
DIESEL GEN.
ABT
15KVA XFORMER
120VAC
DIESEL ROOM DIST. PANEL
CONTROL ROOM
UPS-2 120VAC DIST. PANEL
knife switch
in
ELGAR
out
UPS-3 120VAC DIST. PANEL
WELDING SHOP
REVISIONS
No.
Description
Init.
Date
TITLE
ELECTRICAL DISTRIBUTION
BLOCK DIAGRAM
08/07/90
RESEARCH REACTOR FACILITY
UNIVERSITY OF MISSOURI
DRAWN BY THS
APPROVED
SHEET NO. 1 OF 1
DWG. NO. 2272

Figure 3

SECTION V

NEW TESTS AND EXPERIMENTS
1 July 1989 through 30 June 1990

New experimental programs during this period are as follows:

RUR 274 Experimenter: S. Gunn
Description: This RUR authorizes the irradiation of Potassium Hexachloroiridate (K_2IrCl_6). For the production of Ir^{192} to be used as a radioisotope tracer in oil exploration to determine fracture patterns in rocks.

RUR 274A Experimenter: S. Gunn
Description: This addendum was added to allow the irradiation of Potassium Hexachloroiridate Iridium doped Al_2O_3, for the production of Ir^{192}. To be used as a radioisotope tracer in oil exploration to determine fracture patterns in rocks.

RUR 275 Experimenter: S. Gunn
Description: This RUR authorizes the production of S^{35}, by the irradiation of Potassium Chloride. This isotope is used to label organic compounds for industry.

RUR 277 Experimenter: S. Gunn
Description: This RUR authorizes the irradiation of Strontium Carbonate to produce Sr^{85} and Sr^{89}. These isotopes are used by radiochemical companies in blood flow studies.

RUR 278 Experimenter: S. Gunn
Description: This RUR authorizes the irradiation of Lutetium Oxide enriched to in Lu^{176} up to 100%. Used for research testing and labeling antibodies for cancer studies.

RUR 282 Experimenter: S. Gunn
Description: This RUR authorizes the irradiation of Osmium metal, natural and enriched. The Osmium is used to produce Ir^{191m} for heart studies in implants.

RUR 285 Experimenter: S. Gunn

Description: This authorizes the irradiation of a thin UO_2 (Uranium Oxide) deposition on titanium foil. This will be used for Nuclepore's new irradiator case and are test runs.

RUR 286 Experimenter: S. Gunn

Description: This authorizes the irradiation of Antimony Oxide (Sb_2O_4) for industrial use as a tracer in oil exploration to determine fracture patterns in rocks.

RUR 287 Experimenter: S. Gunn

Description: This authorizes the irradiation of Scandium Chloride ($ScCl_3$) for the production of Sc^{46}. This is used as a industrial tracer for oil exploration to determine fracture patterns in rocks.

Each of these experiments has a written safety evaluation on file which provides the basis for the determination that it does not involve an unreviewed safety question as per 10 CFR 50.59.

SECTION VI

SPECIAL NUCLEAR MATERIAL ACTIVITIES
1 July 1989 through 30 June 1990

1. SNM Receipts: A total of 22 new fuel elements were received from Babcock and Wilcox (B & W), Lynchburg, Virginia.

Shipper	Elements	Grams U	Grams U-235
B & W	MO241, MO292, MO293, MO294, MO295, MO296, MO297, MO298, MO299, MO300, MO301, MO302, MO303, MO304, MO305, MO306, MO307, MO308, MO309, MO310, MO311, MO312	18,256	17,008

2. No Spent fuel elements were shipped.

3. Inspections: There were no Physical Security and Special Nuclear Material accountability inspections conducted by the Nuclear Regulatory Commission.

4. SNM Inventory: As of 30 June 1990, MURR was financially responsible for the following DOE owned amounts:

   Total U = 49,788 grams
   Total U-235 = 44,246 grams

   Included in these totals are 36 grams of U and 34 grams of U-235 non-fuel, DOE owned. In addition to these totals, MURR owns 156 grams of U and 74 grams of U-235. All of this material is physically located at the MURR.

The fuel elements on hand have accumulated the following burnups as of 30 June 1990:

Burned-up Elements

Element No.	MWD	Element No.	MWD	Element No.	MWD
MO-232	145.46	MO-260	134.19	MO-274	148.75
MO-234	145.46	MO-261	135.40	MO-275	144.91
MO-239	145.05	MO-262	129.63	MO-276	148.04
MO-240	145.05	MO-263	135.36	MO-277	146.73
MO-246	143.80	MO-264	129.63	MO-278	148.04
MO-247	146.78	MO-265	135.36	MO-279	146.73
MO-248	143.80	MO-266	132.01	MO-280	146.34
MO-249	146.78	MO-267	123.08	MO-281	143.00
MO-254	145.15	MO-268	132.01	MO-282	146.34
MO-255	126.70	MO-269	123.08	MO-283	143.00
MO-256	146.15	MO-270	144.50	MO-284	148.85
MO-257	126.70	MO-271	144.50	MO-285	146.76
MO-258	134.19	MO-272	148.75	MO-286	148.85
MO-259	135.40	MO-273	144.91	MO-287	146.76

Elements in Service

MO-241	119.19	MO-297	72.59	MO-307	34.22
MO-288	112.41	MO-298	103.68	MO-308	15.64
MO-289	140.88	MO-299	67.45	MO-309	34.22
MO-290	112.41	MO-300	50.98	MO-310	15.64
MO-291	140.88	MO-301	67.45	MO-311	0.00
MO-292	81.72	MO-302	50.98	MO-312	0.00
MO-293	119.19	MO-303	38.73	MO-313	0.00
MO-294	81.72	MO-304	39.45	MO-314	0.00
MO-295	72.59	MO-305	38.73		
MO-296	103.68	MO-306	39.45		

Average Burnup: 109.67 MWD

SECTION VII

REACTOR PHYSICS ACTIVITIES
1 July 1989 through 30 June 1990

1. Fuel Utilization: During the period, 1 July 1989 through 30 June 1990, the following elements reached licensed or feasible burnup and were retired:

Serial Number	Final Core	Date Last Used	MWD
MO258	89-42	08-14-89	149.49
MO260	89-42	08-14-89	149.49
MO262	89-56	10-23-89	149.80
MO264	89-56	10-23-89	149.80
MO266	89-41	08-07-89	149.81
MO267	89-48	09-09-89	146.32
MO268	89-41	08-07-89	149.81
MO269	89-48	09-09-89	146.32
MO270	89-48	09-09-89	144.50
MO271	89-48	09-09-89	144.50
MO272	90-20	04-30-10	148.75
MO273	90-02	01-15-90	144.91
MO274	90-20	04-30-90	148.75
MO275	90-02	01-15-90	144.91
MO276	89-66	12-26-89	148.04
MO277	89-64	12-11-89	146.73
MO278	89-66	12-26-89	148.04
MO279	89-64	12-11-89	146.73
MO280	90-13	03-19-90	146.34
MO281	90-19	04-23-90	143.00
MO282	90-13	03-19-90	146.34
MO283	90-19	04-23-90	143.00
MO284	90-21	05-07-90	148.85
MO285	90-27	06-11-90	146.76
MO286	90-21	05-07-90	148.85
MO287	90-27	06-11-90	146.76

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. 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.

Fabrication Core No.	Serial No.	InitialCore Load No.	Initial Operating Date
52	MO241	89-41	07-31-89
52	MO292	89-45	08-28-89
52	MO293	89-41	07-31-89
52	MO294	89-45	08-28-89
53	MO295	89-51	09-18-89
53	MO296	89-54	10-10-89
53	MO297	89-51	09-18-89
53	MO298	89-54	10-10-89
53	MO299	89-61	11-20-89
53	MO300	90-02	01-08-89
53	MO301	89-61	11-20-89
53	MO302	90-02	01-08-90
54	MO303	90-10	02-19-90
54	MO304	90-13	03-12-90
54	MO305	90-10	02-19-90
54	MO306	90-13	03-12-90
54	MO307	90-20	04-23-90
54	MO308	90-24	05-20-90
54	MO309	90-20	04-23-90
54	MO310	90-24	05-20-90

2. Fuel Shipping: No spent fuel was shipped.

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 30 June 1990, 115 fuel assemblies fabricated by Babcock and Wilcox had been received and 111 used in cores at 10 MW.

4. Licensing Activities: On 6 June 1990, the Nuclear Regulatory Commission approved Amendment No. 19 to the Facility Operating License No. R-103.

This amendment temporarily increased the Special Nuclear Material Inventory under Facility license R-103 pending the establishment of capability for the offsite shipment of spent fuel. As part of its annual reporting requirements, the status of establishing this spent fuel shipping capability is described below:

On April 18, 1990, MURR submitted a request to the Nuclear Regulatory Commission (NRC) to amend the BMI-1 spent fuel shipping package Certificate of Compliance to authorize MURR to use this cask. On July 6, 1990, the NRC submitted four questions to MURR concerning our request. The answers to these questions are being prepared and will be sent to the NRC in mid August.

A submittal was made September 12, 1986 pertaining to the new MURR fuel design with associated revisions to the Technical Specifications. The fuel design has been evaluated by the NRC and Amendment No. 20 was issued August 1, 1990 approving the new fuel design. A description of this amendment will be provided in the 1990-1991 annual report.

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:

Sixty-five refueling evolutions were completed. An excess reactivity verification was performed for each refueling and the average excess reactivity was 1.88%. The largest excess reactivity was 2.64%. MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

Reactivity measurements were performed for 10 evolutions to verify reactivity parameters for the flux trap. The complete worth curves of the four shim and one regulating blade were obtained after the beryllium reflector changeout in November, 1989.

Physical inspections of the following fuel elements were performed to verify operational parameters.

MO-262 from Core 44	8/11/89
MO-264 from Core 49	8/11/89
MO-283 from Core 51	11/15/89
MO-280 from Core 51	2/8/90
MO-272 from Core 50	4/18/90

All measurements were within operational requirements.

SECTION VIII

SUMMARY OF RADIOACTIVE EFFLUENT RELEASED TO THE ENVIRONMENT

Sanitary Sewer Effluent

1 July 1989 through 30 June 1990

Descending Order of Activity Released for Isotope Totals > 1.00E-5Ci

Nuclide	Amount (Ci)	Nuclide	Amount (Ci)
H-3	5.55E-01	W-188	1.23E-04
S-35	1.47E-02	Rh-105	1.13E-04
Zn-65	7.10E-03	Eu-154	8.90E-05
As-77	4.07E-03	Fe-59	8.07E-05
Ca-45	3.40E-03	Nb-95	8.01E-05
Co-60	1.24E-03	Pt-191	7.26E-05
Cu-64	9.82E-04	Cu-67	6.32E-05
Tc-99m	9.81E-04	Rb-86	3.93E-05
Re-186	9.54E-04	K-42	3.92E-05
Sc-46	9.52E-04	Zr-95	3.36E-05
Cr-51	7.25E-04	Sb-124	3.25E-05
Sm-153	6.36E-04	Ho-166	2.65E-05
Ag-110m	4.61E-04	Mn-54	2.54E-05
Eu-152	3.86E-04	Ta-182	1.96E-05
Ba-131	3.37E-04	Sb-122	1.81E-05
Se-75	2.62E-04	Pa-233	1.28E-05
Na-24	2.39E-04	Gd-159	1.27E-05
Cd-109	2.23E-04		

Stack Effluent
1 July 1989 through 30 June 1990

Ordered by % Technical Specification (TS) Limit

Isotope	Tot. Release FY 89-90 (Ci)	Average Concentration (µCi/ml)	TS Limit (x MPC)	% TS*
Ar-41	5.9E+02	2.0E-06	350	14.286
I-131	5.4E-04	2.1E-12	1	2.121
K-40	1.3E-04	5.1E-13	1	0.513
Eu-154	3.7E-05	1.5E-13	1	0.145
Os-191	2.8E-03	1.1E-11	1	0.110
Eu-152	4.9E-05	1.9E-13	1	0.048
W-188	9.9E-06	3.9E-14	1	0.039
I-135	1.2E-02	4.8E-11	350	0.014
H-3	2.3E+00	8.8E-09	350	0.013
Co-60	9.2E-06	3.6E-14	1	0.012
I-133	4.1E-03	1.6E-11	350	0.012
Se-75	9.1E-05	3.6E-13	1	0.009
I-134	4.6E-02	1.8E-10	350	0.009
V-52	2.3E-01	8.9E-10	350	0.008
Cd-109	2.5E-05	9.8E-14	1	0.005
Ce-139	1.1E-06	4.5E-15	1	0.004
Pd-103	3.2E-04	1.3E-12	1	0.004
Te-125m	3.7E-05	1.4E-13	1	0.004
I-132	8.9E-03	3.5E-11	350	0.003
Cl-38	1.8E-01	6.9E-10	350	0.003
Cs-137	3.5E-06	1.4E-14	1	0.003
Ce-144	1.3E-06	5.0E-15	1	0.003
Hg-203	2.5E-05	9.7E-14	1	0.002
Co-57	2.9E-05	1.1E-13	1	0.002
Zr-95	4.4E-06	1.7E-14	1	0.002
Ba-140	4.3E-06	1.7E-14	1	0.002
Xe-135m	3.7E-02	1.5E-10	350	0.001
Eu-155	9.0E-06	3.6E-14	1	0.001
Sc-46	2.1E-06	8.2E-15	1	0.001
Te-123m	1.7E-07	6.8E-16	1	0.001
Ta-182	1.6E-06	6.2E-15	1	0.001
Total				17.381

* Isotopes observed at <0.001% TS limit not listed.

Stack flow rate ~ 20,500 ft.^{3}/min. from 7/1/89 to 5/13/90. Following ventilation upgrade, stack flow rate ~ 33,500 ft.^{3}/min. from 5/14/90 to 6/30/90. (See Section IV, Plant and System Modifications)

Amended Table *
Stack Effluent
1 July 1988 through 30 June 1989
Ordered by % TS

Isotope	Tot. Release FY 88-89 (Ci)	Average Concentration (µCi/ml)	TS Limit (x MPC)	% TS*
Ar-41	9.2E+02	3.6E-6	350	25.857
I-131	6.1E-4	2.4E-12	1	2.417
Eu-154	1.0E-5	3.9E-14	1	0.039
H-3	2.8E+0	1.1E-8	350	0.017
I-135	1.0E-2	4.0E-11	350	0.011
I-133	4.0E-3	1.6E-11	350	0.011
Co-60	7.5E-6	3.0E-14	1	0.010
Eu-152	9.5E-6	3.7E-14	1	0.009
Cd-109	2.9E-5	1.1E-13	1	0.006
I-134	2.9E-2	1.1E-10	350	0.005
Ce-144	2.6E-6	1.0E-14	1	0.005
Ce-139	1.2E-6	4.7E-15	1	0.005
Se-75	4.5E-5	1.8E-13	1	0.004
V-52	1.1E-1	4.3E-10	350	0.004
I-132	7.6E-3	3.0E-11	350	0.003
Hg-203	2.5E-5	1.0E-13	1	0.003
Na-22	1.8E-6	7.0E-15	1	0.002
Cs-137	2.0E-6	8.0E-15	1	0.002
Te-125m	1.2E-5	4.7E-14	1	0.001
Xe-135m	2.3E-2	9.2E-11	350	0.001
Br-82	4.6E-3	1.8E-11	350	0.001
Zn-65	2.8E-6	1.1E-14	1	0.001

Other isotopes observed at <0.001% TS limit.
Stack flow rate ~ 17,100 cfm.

* An error in data entry for the assembly of the 1988/89 Stack Effluent Table was discovered following submittal of the 1988/89 Operations Annual Report. The error involved adding the same isotope data more than one time which inflated some of the % TS totals. Several of the corrected totals were < 0.001% and so some of the isotopes originally reported are not listed in this corrected table.

SECTION IX

SUMMARY OF ENVIRONMENTAL SURVEYS
1 July 1989 through 30 June 1990

Environmental samples are collected two times per year at eight locations (HP-11: "Environmental Sampling") and analyzed for radioactivity. These locations are shown in Figure 1. Soil and vegetation samples are taken at each location. Water samples are taken at three of the eight locations. Results of the samples are shown in the following tables.

1. Sampled during October 1989.

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.0 pCi/l	2.8 pCi/l	219.0 pCi/l	19.3 pCi/ml of sample
Soil	1.0 pCi/g	4.5 pCi/g	1.9 pCi/g	N/A
Vegetation	2.0 pCi/g	9.3 pCi/g	3.4 pCi/g	19.3 pCi/g distillate

* Gamma and tritium analyses are based on wet weights while alpha and beta analysis are based on dry weights.

Determined Radioactivity Levels
Vegetation Samples

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	Tritium (pCi/g)
1-V-36	< 2.0	26.5	< 3.4	< 19.3
2-V-36	< 2.0	19.5	< 3.4	< 19.3
3-V-36	< 2.0	28.5	< 3.4	< 19.3
4-V-36	< 2.0	12.8	< 3.4	< 19.3
5-V-36	< 2.0	23.6	< 3.4	< 19.3
6-V-36	< 2.0	< 9.3	< 3.4	< 19.3
7-V-36	< 2.0	15.7	< 3.4	< 19.3
10-V-36	< 2.0	23.0	< 3.4	< 19.3

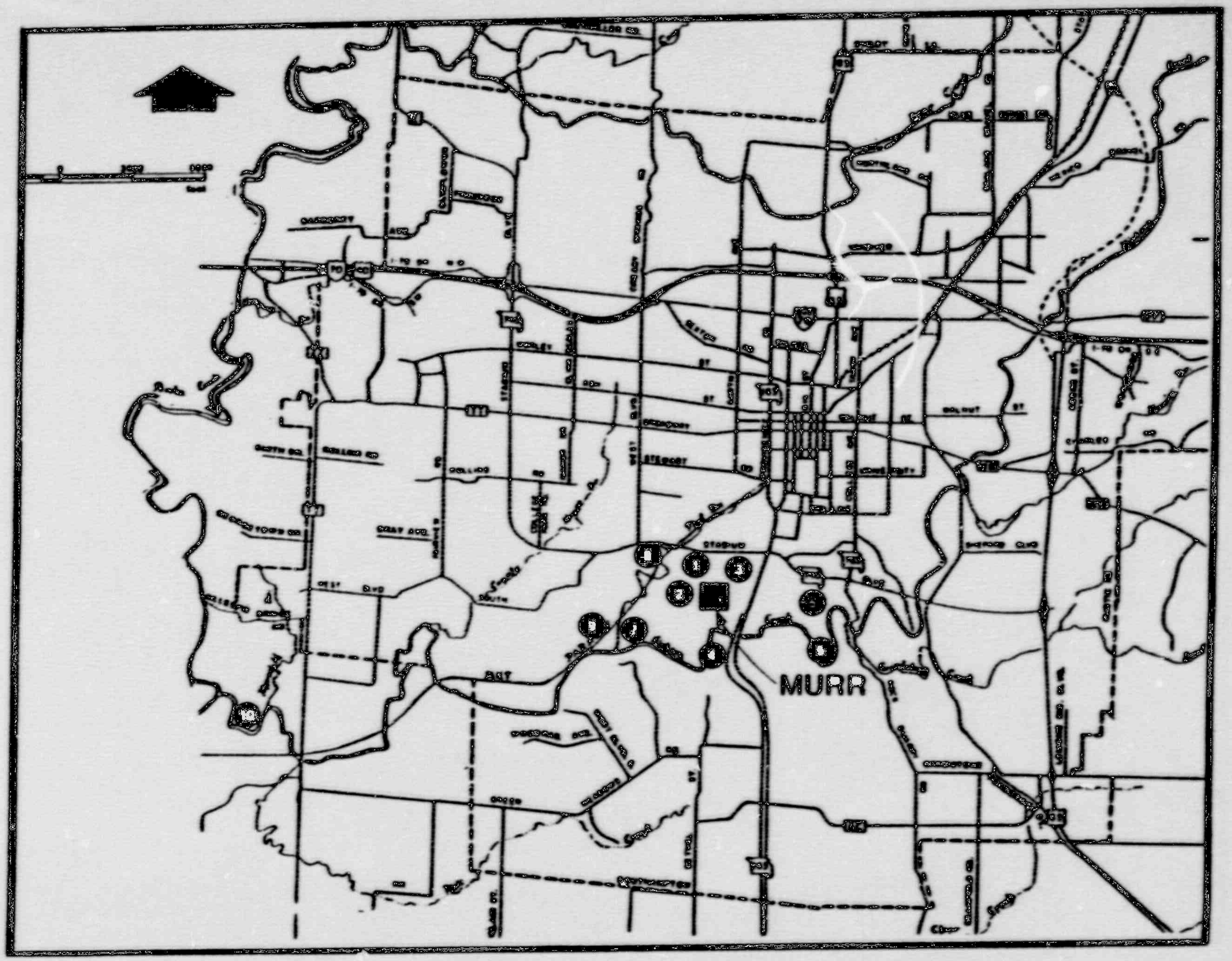


Figure 1. MURR Environmental Program Sample Stations

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)
1-S-36	< 1.0	21.0	5.4
2-S-36	< 1.0	11.7	6.1
3-S-36	< 1.0	9.3	4.2
4-S-36	< 1.0	7.9	4.1
5-S-36	< 1.0	13.2	6.6
6-S-36	< 1.0	< 4.5	< 1.9
7-S-36	< 1.0	10.8	5.5
10-S-36	< 1.0	10.7	5.8

Determined Radioactivity Levels
Water Samples

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	Tritium (pCi/ml)
4-W-36	< 1.0	< 2.8	< 219.00	< 19.3
6-W-36	< 1.0	< 2.8	< 219.00	< 19.3
10-W-36	< 1.0	7.8	< 219.00	< 19.3

2. Sampled during May, 1990

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.0 pCi/l	4.0 pCi/l	228.5 pCi/l	22.5 pCi/ml of sample
Soil	1.0 pCi/g	4.0 pCi/g	1.5 pCi/g	N/A
Vegetation	1.9 pCi/g	8.0 pCi/g	4.2 pCi/g	22.5 pCi/g distillate

* Gamma and tritium analyses are based on wet weights while alpha and beta analysis are based on dry weights.

Determined Radioactivity Levels
Vegetation Samples

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	Tritium (pCi/g)
1-V-37	< 1.9	35.6	< 4.2	< 22.5
2-V-37	< 1.9	28.8	< 4.2	< 22.5
3-V-37	< 1.9	18.2	< 4.2	< 22.5
4-V-37	< 1.9	36.1	< 4.2	< 22.5
5-V-37	< 1.9	29.7	< 4.2	< 22.5
6-V-37	< 1.9	20.4	< 4.2	< 22.5
7-V-37	< 1.9	26.0	< 4.2	< 22.5
10-V-37	< 1.9	29.7	< 4.2	< 22.5

Determined Radioactivity Levels
Soil Samples

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
1-S-37	< 1.0	19.6	7.6
2-S-37	< 1.0	22.6	8.9
3-S-37	< 1.0	18.9	5.0
4-S-37	< 1.0	10.0	4.9
5-S-37	< 1.0	19.5	7.9
6-S-37	< 1.0	10.6	4.2
7-S-37	< 1.0	15.9	6.9
10-S-37	< 1.0	19.9	8.2

Determined Radioactivity Levels
Water Samples

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	Tritium (pCi/ml)
4-W-37	< 1.0	< 4.0	< 228.5	< 22.5
6-W-37	< 1.0	6.2	< 228.5	< 22.5
10-W-37	< 1.0	9.8	< 228.5	< 22.5

ENVIRONMENTAL TLDs

An environmental TLD program was initiated in April 1990 to monitor environmental dose rates surrounding MURR. These TLD monitors are being changed on a quarterly basis. Results from these measurements will be reported in future summaries of environmental surveys.

NUMBER OF FACILITY RADIATION AND CONTAMINATION SURVEYS

	Radiation	Surface Contamination	Air Samples
1989			
July	54	46	21
August	42	34	23
September	46	37	21
October	34	29	22
November	36	30	22
December	36	33	21
1990			
January	31	25	23
February	29	27	20
March	47	44	22
April	40	32	21
May	44	48	23
June	36	36	21
TOTALS	475	421	260

96 Radiation Work Permits were issued during the fiscal year

Miscellaneous Items

In December 1989, Mr. Ronald J. Dobey, Jr., Health Physics Technician, completed his MBA degree and left employment with the University to become an Agreement State Regulator in Kansas. Mr. R. Mark Stumbaugh was hired as a Health Physics Technician in March 1990. Mr. Stumbaugh received his original training in the Nuclear Navy Program, followed by two years in health physics jobs at several nuclear power plants. An additional Health Physics Technician position was established and hiring for that position is underway. Ms. Leslie M. Powell was hired into the newly established secretarial position to support the MURR Health Physics Group. She had been the MURR receptionist for over three years and was familiar with many of the secretarial needs of the Health Physics Group.

Three new Health Physics Standard Operating Procedures were added. HP-34: "MURR Identification Badge Program and Implementation" was established to provide guidelines and policies for the use and issue of identification badges at the MURR facility. HP-35: "Beamport Area Access" was established to define access controls for the area surrounding the beamports following the redefinition of the MURR neutron beams as high radiation areas (see Inspection Report No. 50-186/89001). HP-36: "Remote Sampling of Containment Air" was established to provide the capability of sampling containment building air without entry in the cases where airborne contamination is suspected following containment isolation. Copies of these procedures are attached at the end of this section.

ADCO Services, Inc. has continued to act as our institutional waste broker. Through ADCO, MURR disposed of 798.9 cubic feet of LSA material generated at MURR.

The replacement of the reactor beryllium reflector and graphite reflector wedges (see Section I) was accomplished with a total of 4.96 manrem exposure. The October 1981 changeout of the beryllium reflector had required 14 manrem to complete the job (see Operations Report 1981/82). The prejob review and training utilizing the knowledge gained from this 1981 job helped to identify several ALARA measures which were implemented for the 1989 job; this accomplished a 9 manrem reduction.

Review of dose received for the 1989 job have identified additional ALARA measures to be considered for the next scheduled beryllium reflector changeout.

A program to improve the documentation [illegible] personnel dose review for the purpose of ALARA assessment was [illegible] March 1990. This program has established ALARA reporting criteria and provided an improved mechanism for management review. As the program is being established and tested, assessment is continuing in how to best fit the ALARA review process for the various working groups at MURR. ALARA efforts to reduce extremity exposures in the production of radioisotopes used in radiopharmaceuticals at MURR have continued. Changes in the chemical compound of the target materials have allowed for reduced handling of these materials during processing, which has greatly reduced the extremity exposures received per activity handled.

CHANGES TO HEALTH PHYSICS STANDARD OPERATING PROCEDURES

MADE FROM 1 JULY 1989 THROUGH 30 JUNE 1990

There were three new additions to the Health Physics SOP manual during the year (#HP-34, #HP-35 and #HP-36). These additions are contained in this section.

MURR Identification Badge Program and Implementation

I. Policy

All personnel with unescorted access to the facility shall wear I.D. badges to aid in maintaining the security of the MURR facility by preventing unauthorized access.

II. Purpose

To provide guidelines and policies for the use and issue of identification badges at the MURR facility.

III. General

Personnel at the facility will be issued I.D. badges based on level of access, blue for containment access and orange for lab access. Personnel having containment combination access will be identified by a special hole punch in the white side of the badge. This will assist in maintaining positive control of the combination. Along the bottom of the badge the individual's name will be printed.

Temporary badges will also be available for use as spares and for personnel who have unescorted status but visit the site infrequently. These badges will appear much like the permanently assigned badges with the following exceptions: in place of a photo the word "TEMP" will be visible; and instead of a name a serialized number will be used for identification at the bottom of the badge. These will be maintained at the Front Desk and in the Control Room and will be logged out as needed.

Personnel requiring an escort will be recognizable by their lack of an I.D. badge. All personnel at the facility without an I.D. badge shall be escorted by badged personnel.

IV. Responsibility

Inside the facility, I.D. badges are to be worn at all times and shall be worn visibly on the front of the body. Supervisors will be responsible to ensure that people in their group wear their badges.

Lost, misplaced, or defaced badges will be replaced at a cost of $2.00 (cost of materials) for the first replacement and $5.00 each subsequent replacement. Chronic loss or forgetting of badges will be reviewed and could result in loss of access to the facility.

During non-working hours each person will be responsible for the safe, secure keeping of the issued I.D. badge. Badges shall be kept in a manner which will preclude theft or misuse of this identification material. They should not be hung from rear view mirrors or left on car seats or in any unsecured area where theft could occur.

At the time of termination of access to the MURR facility, the individual and sponsor will ensure that the I.D. badge is turned in to the receptionist for proper disposition.

Any unescorted personnel inside the facility without an I.D. badge shall be challenged and the Control Room notified of the unauthorized entry. The individual shall then be escorted to the lobby for interrogation by the receptionist or reactor operator. This applies as well to a person with lab access I.D. badge found unescorted inside containment.

V. Procedure

The materials used to produce the badges will be assigned as follows: ID camera and film to Health Physics; and the badge blanks, lamination folders, die cutter, and lamination machine to the Director's Office. The name or number will be printed by Kroy lettering. This will be done with cooperation between HP and the Director's Office.

Issuance of identification badges will be as follows: the individual will be photographed following indoctrination and this photo will be given to Directo[illegible]ice personnel for subsequent badge assembly. At this time the new personnel will be given a temporary I.D. badge while awaiting permanent I.D. badging. The new personnel should normally receive their permanent I.D. badge within tw[illegible] weeks.

The designation of combination access will be made by the Reactor Manager. As such, the [illegible]ol used to delineate this will be maintained in the Con[illegible] Room. Once an individual is on the list of persons authorized to have containment

entry, the operators will be able to give the combination and make the designation symbol on the I.D. badge.

During normal working hours, issuance of temporary I.D. badges will be done at the Front Desk in the lobby. The receptionist will verify the individuals access level and then log out by serial number a temporary badge to the person based on access level. After normal working hours temporary badges shall be obtained by contacting the Control Room (#13). The operations personnel on shift will verify access level and issue the appropriate I.D. badge and log the badge out to the individual. Temporary badges shall be returned at the end of the use to the respective issuing place.

SOP HP-35

Rev. new Page 1 of 3

Appr'd S.M. Langhorst

Date 9/1/89

Beamport Area Access

I. 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.

II. Purpose

The purpose of controlling access to the beamport area is to ensure compliance with 10 CFR 20.203(c): "High radiation areas."

III. Definitions

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

Radiation Area means any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 mrem, or in any 5 consecutive days a dose in excess of 100 mrem.

High Radiation Area means any area, accessible to personnel, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 mrem.

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.

IV. Responsibilities

A. Access Control

1. Limited to authorized individuals.
2. Guests approved by Health Physics prior to escorted entry by an authorized individual.

3. Access control required during reactor operation.

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

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

B. Training

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

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

C. Door Control

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

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

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

D. Posting

1. Entry points to the beamport area shall be posted as per 10 CFR 20.203(c)(1) with the phrase, "in the beam", added.

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

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

E. Radiation Surveys

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

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

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

4. 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.

5. 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.

Remote Sampling of Containment Air

I. Policy

When containment isolation has occurred and there is indication that airborne contamination exists, an estimation of MPC shall be made before reentry of personnel into containment, except for cases of life-saving and accident mitigating activities (SEP-11).

II. Purpose

This procedure will be used to obtain air sample(s) using the remote containment sampling station. The sample(s) will then be analyzed to estimate MPC levels prior to reentry of personnel into containment.

III. Scope

This procedure will apply in cases where airborne contamination is suspected following containment isolation. Airborne contamination will be suspected by increased stack monitor readings(s), sustained increases in several of the ARMS readings, or by the circumstances leading to the isolation. This procedure will not be required in the cases of life-saving and accident mitigating activities (SEP-11).

IV. Procedure

A. The remote sampling station is located in the basement area next to the pneumatic tube blower system. A schematic for the remote sampling station is shown in Figure 1.

B. Obtain an air pump, hose connectors, and tubing adequate to sample the system. Connect pump hose to sample from the reference can line (through Valves 1 and 2) and exhaust to the containment sensing line (through Valves 3 and 4).

C. Open isolation valves in number sequence and flush the system (sample line volume is approximately 0.5 ft^3). Monitor dose rate around pump during this flush.

D. Close Valve 2, and with the pump still running, disconnect hose at Valve 2. Connect evacuated air sample can at Valve 2 connection, and open Valve 2 and the sample can valve to obtain containment air sample. Close both valves, disconnect sample can and reconnect pump hose. If dose rates are acceptable, Valve 2 may be opened and the system allowed to continuously flush in preparation for any further sampling.

E. Analyze sample can via gamma spectroscopy to identify isotopic contamination and estimate MPC levels in containment air. This information will be included in the review of precautions required for reentry into containment or recovery from containment isolation.

F. This remote sampling station may also be utilized to obtain other types of air samples, such as filters.

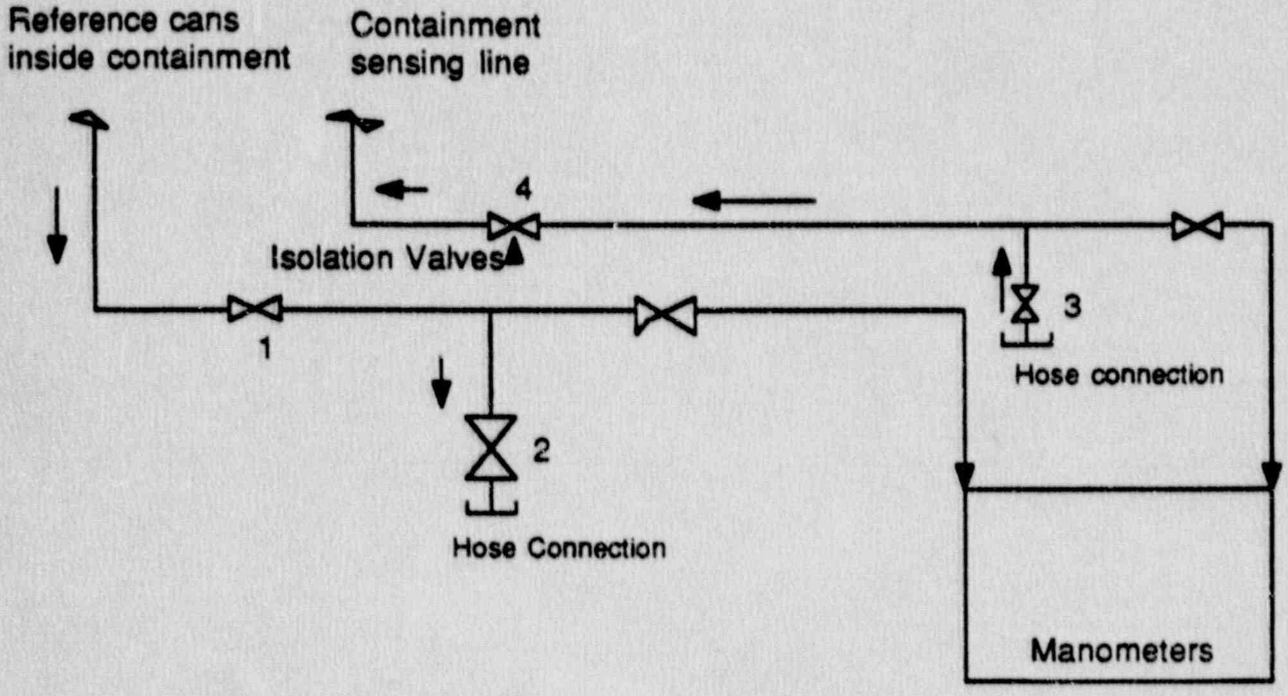


Figure 1. Remote Sampling Station for Containment Air

SECTION X

SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS
1 July 1989 through 30 June 1990

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.

PERMANENT ISSUE FILM-BADGES

Beta, Gamma, Neutron (Deep Dose) Wholebody Badges:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	120	125	107	104	116	129	115	109	131	136	129	109
AME	48	53	64	69	58	45	61	70	53	45	63	61
AE	67	68	66	56	100	60	79	63	73	82	74	67
HE	260	210	280	170	400	190	270	390	320	250	270	220

Beta and Gamma (Deep Dose) Wholebody Badges:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	50	46	43	48	49	50	49	49	59	58	55	50
AME	0	5	2	5	4	4	3	3	0	1	5	7
AE	0	16	15	12	15	20	27	17	0	10	24	17
HE	0	30	20	20	30	30	40	30	0	10	40	20

TLD Finger Rings*:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	66	70	60	62	58	67	62	67	72	68	68	61
AME	54	50	50	54	56	52	55	49	51	52	59	68
AE	133	158	171	204	186	146	159	155	188	184	189	199
HE	710	630	900	1500	500	960	830	740	900	910	740	1620

* Includes Monthly and bi-weekly ring badges

SUMMARY OF RADIATION EXPOSURES TO
FACILITY STAFF, EXPERIMENTERS AND VISITORS
1 July 1989 through 30 June 1990
(Continued)

SPARE ISSUE FILM-BADGES

Beta, Gamma, Neutron (Deep Dose) Wholebody Badges:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	51	48	54	49	56	54	34	56	126	66	56	71
AME	5	55	1	6	30	1	21	10	14	4	1	10
AE	30	46	260	33	49	30	19	25	27	43	20	31
HE	70	130	260	130	110	30	50	90	90	80	20	50

Beta and Gamma (Deep Dose) Wholebody Badges:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	46	44	46	58	69	57	54	77	104	70	56	52
AME	1	2	0	0	0	1	1	6	8	0	0	3
AE	10	10	0	0	0	10	10	33	35	0	0	20
HE	10	10	0	0	0	10	10	60	70	0	0	20

TLD Finger Rings:

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	32	97	36	94	117	87	93	52	108	91	93	91
AME	8	40	3	27	48	28	39	31	42	22	19	20
AE	100	148	210	101	71	153	134	107	111	89	98	104
HE	280	760	320	890	230	580	1750	870	870	320	290	330

SELF READING DOSIMETERS

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
ME	3	1	17	10	1	6	0	2	8	0	6	8
AME	79	82	62	70	79	73	79	75	71	78	70	68
AE	47	55	58	64	88	57	52	57	57	49	60	64
HE	260	220	250	230	450	253	292	280	355	225	235	212