UNIVERSITY OF MISSOURI-COLUMBIA

Research Reactor Center

Research Park
Columbia, Missouri 65211
Telephone (573) 882-4211
FAX [573] 882=3443

February 28, 1997

Director of Nuclear Reactor Regulation
ATTN: Document Control Desk
Mail Station P1-37
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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

Enclosed is one copy of the Reactor Operations Annual Report for the University of Missouri Research Reactor. The reporting period covers 1 January 1996 through 31 December 1996.

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

Sincerely,

Walt A. Meyer Jr.

Walt A. Meyer Jr.
Reactor Manager

bjb

enclosure

xc: Seymour H. We[illegible], USNRC

IE47 1/1

9703070165 961231
PDR ADOCK 05000186
R PDR

070068

UNIVERSITY OF MISSOURI

UNIVERSITY OF MISSOURI RESEARCH REACTOR

REACTOR OPERATIONS ANNUAL REPORT

1 January 1996 - 31 December 1996

RESEARCH REACTOR FACILITY

UNIVERSITY OF MISSOURI

RESEARCH REACTOR FACILITY

REACTOR OPERATIONS

ANNUAL REPORT

1 January 1996 - 31 December 1996

Compiled by the Reactor Staff

Submitted February 1997 by

Walt A. Meyer, Jr.
Reactor Manager

Reviewed and Approved

J. Charles McKibben
Associate Director

TABLE OF CONTENTS

SECTION I
REACTOR OPERATIONS SUMMARY

1 January 1996 through 31 December 1996

The following table and discussion summarize reactor operations in the period 1 January 1996 through 31 December 1996.

Date	Full Power Hours	Megawatt Days	Full Power % of Total Time	Full Power % of Schedule*
Jan 1996	647.70	270.00	87.06	97.50
Feb 1996	643.33	268.14	92.43	103.52
Mar 1996	667.27	278.23	89.69	100.45
Apr 1996	623.69	260.02	86.62	97.02
May 1996	663.80	276.84	89.22	99.93
Jun 1996	660.25	275.20	91.70	102.70
Jul 1996	638.46	266.22	85.81	96.11
Aug 1996	689.36	287.33	95.74	103.77
Sep 1996	641.65	267.49	89.12	99.81
Oct 1996	684.13	285.14	91.95	102.99
Nov 1996	669.13	278.89	92.93	104.09
Dec 1996	678.35	282.77	91.18	102.12
Total for Year	**7,907.12**	**3,296.27**	**90.29% of Time for Year at 10 MW**	**100.8 % of Sched. Time for Yr. at 10 MW**

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

There were nine unscheduled shutdowns recorded during the period 1 January 1996 through 31 December 1996. Of these unscheduled shutdowns, seven were scrams and two were rod run-ins.

Two of the unscheduled shutdowns were manually initiated scram or rod run-in to allow investigation and/or repair of various reactor equipment. Of the remaining seven unscheduled shutdowns, six were spurious, and one was due to low fire main pressure.

There were two Licensee Event Reports (LERs) submitted to the NRC in 1996. One in February regarding reactor operation with the regulating blade inoperable for less than 5 minutes in January 1996, and one in July regarding a determination that, subsequent to a week's reactor operation, the Emergency Generator would not have been operable. Neither of the events reported in the LERs represented a safety concern to the reactor or the public.

All Technical Specification required surveillance tests were completed within specified intervals. The surveillance test results are documented to allow for inspection. The surveillance indicated compliance with Technical Specification requirements.

January 1996

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

On January 23, a manual scram was initiated by the console reactor operator upon discovering that the regulating blade was not operating properly. Electronics technicians discovered, and replaced, a bad bearing in the gearbox input shaft coupling. The regulating blade was tested satisfactorily, and returned to normal operation. A Licensee Event Report was written regarding this failure which involved non-compliance with Technical Specification 3.2.a, which states, "All control blades, including the regulating blade, shall be operable during reactor operation."

On January 29, during scheduled maintenance with the reactor shutdown, one of two redundant anti-siphon valves (V543A) was found to be inoperable. Compliance testing of the anti-siphon system was performed to verify the redundant valve (V543B) was operable. This test verified that the siphon break system was operable as required by Technical Specification 3.9.a. Operability of the siphon break system is also verified at each reactor startup as part of the startup procedure for the primary system.

Special Maintenance Procedure, SMP-10 was performed to investigate the V543A failure. The cause of failure was a missing pin connecting the valve stem to the actuating linkage. The valve was removed, rebuilt and tested, and returned to the system. A new pin with a keeper assembly was installed to ensure the pin could not work its way out of the adaptor. This pin had previously been staked into place. The adaptor pin for the redundant valve, V543B, was inspected to ensure a similar problem with it was not occurring.

Details of the valve failure and corrective actions were reviewed by the Action Subcommittee (a subset of the Safety Subcommittee) on February 12, 1996. These details were reviewed by the full Safety Subcommittee at the June 5, 1996, meeting.

Other major maintenance items for the month included: replacing the bearing in the input shaft coupling gearbox of the regulating blade; installing a south pneumatic tube terminal in graphite wedge #3; installing new 'G' and 'H' graphite wedges for sample calibration.

February 1996

The reactor operated continuously in February with the following exceptions: four shutdowns for scheduled maintenance and refueling.

On February 5, 1996, after shutting down the reactor for a regularly scheduled maintenance day, the control room operator found that anti-siphon valve V543A failed to open as expected while securing the primary system. The redundant anti-siphon valve V543B opened as expected.

The air operator for V543A had not cycled, which indicated a failure of its three-way solenoid valve to operate normally to vent the air operator and allow spring force to open V543A.

Compliance testing of the anti-siphon system was performed to verify that V543B was operable. This test verified that the siphon break system was operable as required in Technical Specification 3.9.a.

The failure of the three-way solenoid valve for V543A was investigated by the Reactor Manager to determine if the previous week's maintenance on this solenoid had been performed correctly. A new seal kit had been installed and was verified to be installed correctly. Subsequent rebuilding of the solenoid valve on February 5 resulted in the valve failing to vent after several successful cycles of operation. The entire three-way solenoid for V543A was replaced. Valve 543A was cycled successfully over twenty times. Compliance testing was completed to verify that both anti-siphon valves were operable prior to resuming reactor operation. Subsequent bench testing of the three-way solenoid valve indicated an O-ring seal problem associated with the operating piston in the valve. This operating piston was removed from service.

Details of the failure and corrective actions were reviewed by the Reactor Action Subcommittee on February 12, 1996. The details were reviewed by the full Safety Subcommittee at the June 5, 1996, meeting.

Major maintenance for the month included: re-installing old 'G' and 'H' graphite wedges; replacing the leading trolley hanger bolt and tension spring on the inner personnel airlock door.

March 1996

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

On March 29, a manual scram was initiated by the duty operator after receiving and verifying a alarm indicating that the fire main water pressure had dropped below the pressure sufficient to supply at least 1,000 gallons per minute to the emergency pool fill system as specified by Technical Specification 3.1(c). The loss of fire main system pressure was caused by a fire hydrant pipe rupture during excavation remote from the reactor facility. After the broken fire hydrant was repaired, fire main water pressure was returned to normal and the reactor was refueled and returned to operation.

Major maintenance items for the month included: shipping sixteen spent fuel elements; replacing the cable to the channel 4 nuclear instrument detector; loading two new deionization beds for use on the pool and primary systems.

April 1996

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

Major maintenance items for the month included: completing the biennial change-out of control blade offset mechanism "B"; replacing the voltage regulator on the wide range monitor; removing experimental cans from beamports "E" and "F", and installing new collimators with new fill and drain lines.

May 1996

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

Major maintenance items for the month included: rebuilding 529 series solenoids B-C-F-G-H-S-V; rebuilding pool pump 508B with a replacement bearing housing including new bearings and seals; replacing the front panel on the Gamma-Metrics neutron flux monitor; installing the vestibule box on beamport 'E'.

June 1996

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

Major maintenance items for the month included: rebuilding the following 529 series solenoid operated valves: D-L-M-N-Q-R-W-U.

July 1996

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

On July 1, the Emergency Generator tripped on high coolant temperature 25 minutes into its weekly 30-minute unloaded exercise. The cause was failure of the water pump. Details of the failure were reported to the NRC in a Licensee Event Report dated July 30, 1996.

On July 2, a rod not in contact with magnet rod run-in occurred when control blade 'B' disengaged from its magnet. No activity was occurring with or near the control blade mechanism when the incident occurred. The control blade drive mechanism amphenol connector was disassembled and the electronics technicians discovered that one of the leads that supplies power to the magnet had broken at the pin solder cup. The pin was re-soldered and the connection tested satisfactorily. The reactor was returned to normal operation.

During the maintenance day shutdown July 9, the intermediate range monitor (channel #2) period indication began oscillating erratically. Electronics technicians replaced the detector and the problem remained. They then replaced the detector cables and connections and the erratic indication ceased. Approximately 3 hours later, a spurious intermediate range monitor (channel #2) short period scram occurred while the reactor was subcritical during a normal startup. All other period and power indications were normal. The IRM channel #2 detector was again replaced and no further problems of this type have occurred.

On July 15, a spurious wide range monitor (channel #4) high power scram occurred simultaneously with a reactor operator closing the channel #4 chart recorder door. All other reactor instrumentation indicated normal prior to and subsequent to the scram. The chart recorder and channel #4 drawer wiring and integrity appeared satisfactory and the problem could not be duplicated. Approximately one minute after a hot startup was completed, another spurious scram occurred when a reactor operator closed the source range monitor chart recorder door. Electronics technicians subsequently discovered

loose connector screws on the channel #4 picoammeter module. The picoammeter module was reseated and the connections were tightened. The instrument functions were tested satisfactorily and the reactor was returned to normal operation.

The channel #4 drawer problems were further investigated during the following maintenance day, July 22. The electronics technicians repaired a broken solder joint on the remote gain potentiometer connector which may have contributed to the July 15 unscheduled shutdowns.

Major maintenance items for the month included: repairing a faulty connector pin on control blade 'B' amphenol connector; performing an overhaul of the diesel emergency generator cooling system in response to its water pump failure July 1, which included replacing the water pump, belts, thermostat, pre-high temp. sensor, pre-low temp. sensor and associated gaskets, cleaning the radiator, and replacing the governor controller; replacing NI channel #2 (IRM) detector and cables; repairing a broken solder joint on the remote gain potentiometer connector on the wide range monitor (channel #4).

August 1996

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

On August 12, a rod not in contact with magnet rod run-in occurred while the reactor was subcritical during a normal startup when control blade "B" disengaged from its magnet. The control rod drive mechanism was removed and some misalignment of the magnet seating surface (the anvil) was noted. The alignment was adjusted and the blade and drive mechanism were further examined and tested and no other problems were noted. The reactor was then returned to normal operation.

Major maintenance items for the month included: repairing an air leak in the actuator for pool isolation valve 509; replacing cooling tower fan #3 motor.

September 1996

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

On September 9, a wide range monitor (channel #4) nuclear instrument anomaly scram occurred. Electronics technicians traced the problem to the wide range monitor high voltage power supply (HVPS). This HVPS was replaced and channel #4 was tested satisfactorily. The reactor was returned to normal operation.

On September 16, a spurious wide range monitor (channel #4) high power scram occurred during a normal reactor startup. No actual high power was indicated on any instrumentation. Electronics technicians traced the problem to the channel #4 detector, which was replaced. Channel #4 was tested satisfactorily and the reactor returned to normal operation.

Major maintenance items for the month included: replacing the sealing gasket air regulator for truck entry door 101; replacing the high voltage power supply on the wide range monitor (channel #4); replacing channel #4 detector; replacing the high voltage power supply on the Gamma-Metrics wide

range amplifier due to source range oscillations; replacing the lower gasket on the north back-up isolation door.

October 1996

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

Major maintenance items for the month included: replacing the lower gasket on the south back-up isolation door; performing the biennial change-out of control blade offset "D"; replacing the calibration feedback module for intermediate range monitor (NI) channel #3.

November 1996

The reactor operated continuously in November with the following exceptions: four shutdowns for scheduled maintenance and refueling. The annual Reactor Operations/Health Physics NRC inspection was performed this month.

Major maintenance items for the month included: replacing the log calibration feedback unit (Z-14) in intermediate range monitor channel #3.

December 1996

The reactor operated continuously in December with the following exceptions: five shutdowns for scheduled maintenance and refueling.

Major maintenance items for the month included: replacing the primary heat exchanger 503B differential pressure meter (for differential pressure transmitter 928B); dumping depleted deionization bed "G" to waste barrels--loading new deionization bed "B".

SECTION II
MURR PROCEDURES

1 January 1996 through 31 December 1996

This section includes the summary of procedure changes required by Technical Specification 6.1.h(4) to be part of the annual report. These procedure changes were reviewed and approved by the Reactor Manager or Health Physics Manager to assure the changes were in accordance with 10 CFR 50.59. These procedure changes are also reviewed by the Procedures Review Subcommittee of the Reactor Advisory Committee to meet 10 CFR 50.59 requirements.

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

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

1. Revision No. 17, dated 1/4/96
   Revision No. 17 incorporated various minor changes which were consistent with the original purpose of the procedures (e.g., grammatical and typographic corrections, or clarifications to existing procedures).

2. Revision No. 18, dated 5/31/96
   Revision No. 18 incorporated various minor changes which were consistent with the original purpose of the procedures (e.g., grammatical corrections, format changes). One significant change was adding to SOP I.4.2 General Operating Policies, the requirements imposed by MURR Materials License Condition 28 when the control room is unstaffed.

3. Revision No. 19, dated 12/4/96
   Revision No. 19 incorporated various minor changes which were consistent with the original purpose of the procedures (e.g., grammatical and typographic corrections, additional clarifications, cross-references to reformatted Health Physics SOPs). One significant change was adding to SOP VIII.2.3, Flux Trap Irradiations, the authorization to run small diameter seal-welded samples in flooded multi-carrier cans. This change is described in Section V, New Tests and Experiments.

B. CHANGES TO THE MURR SITE EMERGENCY PROCEDURES AND FACILITY EMERGENCY PROCEDURES, dated January 1985; revised and reprinted May 13, 1988.

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

1. Revision No. 22, dated 6/12/96
   Revision No. 22 incorporated minor changes which were consistent with the original purpose of the procedures (e.g., telephone number changes, update to emergency call list).

2. Revision No. 23, dated 10/8/96
   Revision No. 23 incorporated minor changes which were consistent with the original purpose of the procedures (e.g., telephone number changes, additional clarifications, updating the facility drawing, and updating the list of contact persons in SEP-7, Public Information Procedure).

C. CHANGES TO HEALTH PHYSICS STANDARD OPERATING PROCEDURES

Manual issued 10/29/90:

HP-42, Rev. 0, dated 7/17/96
New procedure which provides guidance in performing sealed source leak tests.

HP-43, Rev. 0, dated 8/27/96
New procedure which provides instructions for shipping LSA, radioactive waste when a waste broker has been contracted to handle the shipment.

The format of the Health Physics Standard Operating Procedures manual was revised and was reissued in its entirety October 18, 1996. Health Physics and Reactor Chemistry Procedures were divided into eight sections based on their particular application and are now contained in a single manual. The new format was developed in an effort to improve the ease of using the manual. The Table of Contents of the 2nd Edition of the Health Physics Standard Operating Procedures is provided here followed by a summary of revisions to existing procedures and a listing of new procedures.

MURR HEALTH PHYSICS STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

HP/III-13	Rev. 0	Calibration and Operation of Baird Polyspec
HP/III-14	Rev. 0	Calibration and Operation of Eberline BC-4 Beta Counter
HP/III-15	Rev. 0	Portal Monitor Calibration/Optimization
HP/III-16	Rev. 0	Portal Monitor Figure of Merit Functional Test
HP/III-17	Rev. 0	HFM-10 Calibration/Optimization
HP/III-18	Rev. 0	HFM-10 Source Check
HP/III-19	Rev. 0	Efficiency Calibration on VAX
HP/III-20	Rev. 0	Energy Calibration on VAX
HP/III-21	Rev. 0	Reactor Chemistry Trending
HP/III-22	Rev. 0	Quench Curve on the Searle Liquid Scintillation Counter
HP/III-23	Rev. 0	Preparing Tritium Standard for Searle Liquid Scintillation Counter
HP/III-24	Rev. 0	Preparing Europium Sources

IV. HEALTH PHYSICS APPLICATIONS

HP/IV-1	Rev. 1	Standard Contamination Wipe Procedure
HP/IV-2	Rev. 3	Receiving and Opening Packages of Radioactive Material
HP/IV-3	Rev. 1	Transfer of Radioactive Material Within Reactor Building
HP/IV-4	Rev. 1	Murr Hot Cell Operation
HP/IV-5	Rev. 3	Cobalt-60 Facility Safety Checks
HP/IV-6	Rev. 3	Co-60 Facility Pool Water Analysis
HP/IV-7	Rev. 0	Sealed Source Leak Test Procedure

V. ENVIRONMENTAL MONITORING

HP/V-1	Rev. 2	Environmental Sampling
HP/V-2	Rev. 3	Analysis of Radioactivity in Environmental Samples
HP/V-3	Rev. 3	Changing Stack Monitor Filters: NMC Model AM-221 F
HP/V-4	Rev. 0	Changing Stack Monitor Filters: NMC Model RAK
HP/V-5	Rev. 3	Analysis of Particulate and Charcoal Filters
HP/V-6	Rev. 1	Tritium Monitoring of Stack Air Exhaust
HP/V-7	Rev. 4	Waste Tank Analysis
HP/V-8	Rev. 4	Secondary and Sump Water Analysis
HP/V-9	Rev. 0	Survey of Items for Unrestricted Release

VI. WASTE MANAGEMENT

HP/VI-1	Rev. 0	Experimenters Waste Disposal Procedure
HP/VI-2	Rev. 1	Direct Barrel Compaction Operation
HP/VI-3	Rev. 1	Shipment of Radioactive Material NOS, Waste
HP/VI-4	Rev. 4	Exclusive Use Shipment of Radioactive Material, LSA Waste
HP/VI-5	Rev. 0	Non-Exclusive Use Shipment of Radioactive Material, LSA Waste
HP/VI-6	Rev. 1	Shipment of Radioactive Material, LSA Waste or SCO Waste Utilizing a Broker

VII. REACTOR OPERATIONS SUPPORT

HP/VII-1	Rev. 2	Room 114 Unscheduled Entry
HP/VII-2	Rev. 2	Handling Radioactive Material in MURR Pool
HP/VII-3	Rev. 3	Health Physics Monitoring of Beam Ports for Reactor Start-up
HP/VII-4	Rev. 6	Pool and Primary Water Analysis
HP/VII-5	Rev. 3	Spent Fuel Shipping Cask Analysis

VIII. HEALTH PHYSICS EMERGENCY PROCEDURES

HP/VIII-1	Rev. 2	Air Sampling During Reactor Emergency
HP/VIII-2	Rev. 0	Evaluation of Exhaust Gas Stack Monitor Filters in an Emergency
HP/VIII-3	Rev. 1	Remote Sampling of Containment Air

The following existing Health Physics and Reactor Chemistry Standard Operating Procedures were not revised except to change the procedure number to follow the new format:

HP-1	Request for Radiation Safety Evaluation; new # HP/I-1.
HP-2	Room 114 Unscheduled Entry; new # HP/VII-1
HP-9	Standard Contamination Wipe Procedure; new # HP/IV-1
HP-11	Environmental Sampling; new # HP/V-1
HP-12	Transfer of Radioactive Material Within Reactor Building; new # HP/IV-3
HP-13	MURR Hot Cell Operation; new # HP/IV-4
HP-17	H-3 Air Samples; new # HP/II-4
HP-19	Self-Reading Dosimeter Calibration; new # HP/III-2
HP-22	Review of Unplanned Radiation Exposures; new # HP/II-2
HP-28	Exclusive Use Shipment of Radioactive Material, LSA Waste; new # HP/VI-4
HP-29	Health Physics Monitoring of Beam Ports for Reactor Start-up; new # HP/VII-3
HP-30	Evaluation of Exhaust Gas Stack Monitor Filters in an Emergency; new # HP/VIII-2
HP-34	MURR Identification Badge Program and Implementation; new # HP/I-6
HP-35	Beamport Area Access; new # HP/I-7
HP-36	Remote Sampling of Containment Air; new # HP/VIII-3
HP-37	Experimenters Waste Disposal Procedure; new # HP/VI-1
HP-39	Shipment of Radioactive Material NOS Waste; new # HP/VI-3
HP-40	Survey of Items for Unrestricted Release; new # HP/V-9
HP-41	Non-Exclusive Use Shipment of Radioactive Material, LSA Waste; new # HP/VI-5
HP-42	Sealed Source Leak Test Procedure; new # HP/IV-7
RC/II-1	Analysis of Particulate and Charcoal Stack Filters; new # HP/V-5
RC/II-2	Pool and Primary Water Analysis; new # HP/VII-4
RC/III-1	Analysis of Radioactivity in Environmental Samples; new # HP/V-2
RC/III-2	Calibration of Stack Particulate Channel: NMC Model AM-221F; new # HP/III-3
RC/III-3	Calibration of Stack Iodine Channel: NMC Model Am-221F; new # HP/III-4
RC/III-4	Calibration of Stack Gas Channel: NMC Model AM-221F; new # HP/III-5
RC/III-5	Co-60 Facility Pool Water Analysis; new # HP/IV-6

The following is a summary of revisions to existing Health Physics and Reactor Chemistry Standard Operating Procedures:

HP-3 Receiving and Opening Packages of Radioactive Material; new # HP/IV-2. Revised to include directions to verify Project Authorization and material inventory. The revision also includes package receipt requirements specified in 10 CFR 20.

HP-4 Handling Radioactive Material in MURR Pool; new # HP/VII-2. Revised to clarify responsibilities and limitations covered by this procedure.

HP-6 Air Sampling During Reactor Emergency; new # HP/VIII-1. Revised to include steps necessary for relocation of analysis equipment in the event the MURR laboratory building is evacuated.

HP-8 Controlled Special Exposures: ALARA Considerations; new # HP/I-3. Revised to limit the number of reactor positions permitted to authorize a controlled special exposure.

HP-10 Radiation Work Permits; new # HP/I-2. Revised to include more detailed instructions for completing the documentation required for using a Radiation Work Permit.

HP-14 Changing Stack Monitor Filters; new # HP/V-3. The title was revised to specify which stack monitor is covered by this procedure.

HP-18 Calibration of Radiation Survey Instruments; new # HP/III-1. Revised to include a blank example of the Certificate of Calibration used to document instrument calibration.

HP-20 Report of Personnel Contamination; new # HP/II-3. Revised to include a blank example of the survey form used to document personnel contamination.

HP-21 Urine Tritium Analysis; new # HP/II-5. Revised in its entirety to provide more detailed instruction for performing tritium analysis and calculation of sample activity.

HP-24 Issuing Radiation Dosimeters at MURR Reception Desk; new # HP/II-1. Revised to clarify the definition of visitors and temporary workers and provide instructions for issuing appropriate dosimetry.

HP-25 Cobalt-60 Facility Safety Checks; new # HP/IV-5. Revised to incorporate updated instructions for performing radiation alarm detector source checks.

HP-27 Calibration of Sample Counting Systems. Deleted; this procedure was superseded by HP/III-11, -12, -13 and -14.

HP-31 Personnel Indoctrination at MURR; new # HP/I-4. Revised title to distinguish procedure from a newly developed procedure covering other aspects of the indoctrination process.

HP-32 Tm-170 Wafer/Pellet Transfer and Packaging. Deleted; this process is no longer performed at MURR.

HP-33 Operation of Sample Counting Systems. Deleted; this procedure was superseded by HP/III-11, -12, -13 and -14.

HP-38 Direct Barrel Compaction Operation; new # HP/VI-2. Format was revised to comply with standardized method of identifying individual procedural steps.

HP-43 Shipment of Radioactive, LSA Waste Utilizing a Broker; new # HP/VI-6. Revised to include instructions for shipping Radioactive SCO waste.

RC/I-3 Tritium Monitoring of Stack Air Exhaust; new # HP/V-6. Revised to provide directions for using a new sampling station. The revision includes instructions for calculating tritium stack concentration.

RC/II-3 Gamma Analysis of Quality Control Silicon. Deleted; superseded by procedures documented in the Service Applications Silicon program.

RC/IV-2 Waste Tank Analysis; new # HP/V-7. Revised to include instructions for using either the Searle LSC or the new Packard instrument to perform sample analysis.

RC/IV-3 Spent Fuel Shipping Cask Analysis; new # HP/VII-5. Revised in its entirety to provide step by step instructions for performing the sample analysis.

RC/IV-4 Preparation of Waste Tank Carrier Solution & Titration for Use. Deleted; carrier solution is no longer used to treat waste tank water.

RC/IV-5 Gamma Analysis of Flux Monitors. Deleted; flux monitors are now analyzed by protocols developed for individual research applications.

RC/IV-6 Secondary and Drain Tile Sump Water Analysis; new # HP/V-8. Revised to include directions to sample cooling tower and tunnel sump as well as the secondary and drain tile sump.

The following are new Health Physics Standard Operating Procedures issued in 1996:

HP/I-5	MURR Indoctrination Training Program
HP/III-6	Stack Monitor Preventive Maintenance: NMC Model RAK
HP/III-7	Calibration of Stack Monitor System: NMC Model RAK
HP/III-8	Calibration of Stack Particulate Channel: NMC Model RAK
HP/III-9	Calibration of Stack Iodine Channel: NMC Model RAK
HP/III-10	Calibration of Stack Gas Channel: NMC Model RAK
HP/III-11	Calibration and Operation of Canberra Model 2404 Alpha/Beta/Gamma System
HP/III-12	Calibration and Operation of Tennelec LB-5100 Alpha/Beta
HP/III-13	Calibration and Operation of Baird Polyspec
HP/III-14	Calibration and Operation of Eberline BC-4 Beta Counter
HP/III-15	Portal Monitor Calibration/Optimization
HP/III-16	Portal Monitor Figure of Merit Functional Test
HP/III-17	HFM-10 Calibration/Optimization
HP/III-18	HFM-10 Source Check
HP/III-19	Efficiency Calibration on VAX
HP/III-20	Energy Calibration on VAX
HP/III-21	Reactor Chemistry Trending
HP/III-22	Quench Curve on the Searle Liquid Scintillation Counter
HP/III-23	Preparing Tritium Standard for Searle Liquid Scintillation Counter
HP/III-24	Preparing Europium Sources
HP/V-4	Changing Stack Monitor Filters: NMC Model RAK

SECTION III

REVISIONS TO THE HAZARDS SUMMARY REPORT

1 January 1996 through 31 December 1996

These changes were reviewed by licensed staff and by members of the Safety Sub-committee and have been determined not to involve a change in Technical Specifications or an unreviewed safety question as defined in 10CFR50.59.

HAZARDS SUMMARY REPORT (ORIGINAL JULY 1, 1965)

Original HSR, page 3-3, Section 3.2.3, paragraph 1, sentence 2:

Delete: "Each of the two doors is electrically driven closed and when in the closed position contacts a microswitch which activates an air valve to inflate a gasket which seals against the door."

Replace with: "Each of the two doors is electrically driven closed and when in the closed position contacts **in a cam actuated microswitch activate** an air valve to inflate a gasket which seals against the door."

Original HSR, page 3-6, Section 3.2.6, paragraph 2, sentence 1:

Delete: "In addition to the eight pneumatic tubes running through this steel plate there are a number of pipes welded to the plate to permit compression of the building . . . ."

Replace with: "In addition to the eight pneumatic tubes running through this steel plate there are a number of pipes welded to the plate to permit **pressurization** of the building . . . ."

1995 Revision to Original HSR, page 3-7, Section 3.2.8, paragraph 1, sentences 2 and 3:

Delete: "This emergency air compressor normally "rides" on the main air supply line until there is a drop of pressure in the main air line to less than 85 psi. At that time the small emergency air compressor comes on and a check valve closes off all of the compressed air system external to the containment building."

Replace with: "This emergency air compressor normally "rides" on the main air supply line until there is a drop of pressure in the main air line to less than **70** psi. At that time the small emergency air compressor comes on and a check valve closes off all of the compressed air system external to the containment building**, except for backup door supply**."

1995 Revision to Original HSR, page 3-8, Section 3.2.8, paragraph 3, sentence 1:

Delete: "This system is equipped with check valves and automatic starters such that if there is a failure or loss of compressed air from the main unit, the emergency air system will come on and carry the inflatable gaskets and any other air controlled devices associated with the reactor."

Replace with: "This system is equipped with check valves and automatic starters such that if there is a failure or loss of compressed air from the main unit, the emergency air system will come on and carry the inflatable gaskets and any other air controlled devices associated with reactor **isolation**."

Original HSR, page 3-9, Section 3.3, paragraph 2, last sentence:

Delete: "This heavy equipment door to the outside will only be opened when the reactor is completely shut down."

Replace with: "This heavy equipment door to the outside will only be opened when the reactor is **secured**."

Original HSR, page 3-9, Section 3.3, paragraph 3, sentence:

Delete: "Specifically, a high radiation level detected in the off-gas line to the stacks will initiate a signal that will provide building closure."

Replace with: "Specifically, a high radiation level detected in the off-gas line to the stacks **or high radiation at the reactor bridge** will initiate a signal that will provide building closure."

1995 Revision to Original HSR, Figure 3.1:

Replace with: Updated Figure 3.1--Basement Level (MURR Dwg #2269, Sheet 1 of 5, dated 12/19/95)

1995 Revision to Original HSR, Figure 3.2:

Replace with: Updated Figure 3.2--Grade Level Plan (MURR Dwg #2269, Sheet 2 of 5, dated 12/19/95)

1995 Revision to Original HSR, Figure 3.3:

Replace with:
Updated Figure 3.3.a--Third Floor Plan (MURR Dwg #2269, Sheet 3 of 5, dated 12/19/95)
Updated Figure 3.3.b--Fourth Floor Plan (MURR Dwg #2269, Sheet 4 of 5, dated 12/19/95)
Updated Figure 3.3.c--Fifth Floor Plan (MURR Dwg #2269, Sheet 5 of 5, dated 12/19/95)

1995 Revision to Original HSR, Figure 3.8:

Replace with: Updated Figure 3.8--Cooling Tower Building at Grade Plan (dated 5/20/96)

Original HSR, pages 4-5 and 4-6, paragraphs 2 and 3; 1968 Revision to Original HSR:

Delete: "The shim blades are constructed of formed boral plate. The neutron absorbing material is 50% boron carbide and 50% aluminum, by weight. The boron carbide-aluminum mixture is clad with .030 inches of aluminum. The nominal blade thickness is 0.200 (rev 1968) inches.

The sides and bottom of the blades have a 1.0 inch aluminum frame where the blade thickness is 0.25 inches."

Replace with: "The shim blades are constructed of formed boral plate. The neutron absorbing material is **nominally** 50% boron carbide and 50% aluminum, by weight. The boron carbide-aluminum mixture is **nominally** clad with **0.0375** inches of aluminum. The nominal blade thickness is **0.175** inches.

The sides and bottom of the blades have a **0.25** inch aluminum frame where the blade thickness is 0.25 inches."

Original HSR, page 5-8, Section 5.4.2:

Delete: "The secondary water flows on the shell side of the reactor primary and pool heat exchangers. These exchangers are as described in Sections 5.2.3 and 5.3.5."

Replace with: "The secondary water flows on the shell side of the reactor primary heat **exchanger, and on the opposite plate side of the pool coolant in the pool heat exchanger**."

1974 and 1971 revisions to Original HSR, page 5-9, Section 5.4.3, paragraph 1:

Add the following sentence to end of paragraph:

"The fans will be configured to run as necessary to provide sufficient cooling for reactor 10 MW operation."

Original HSR, Figure 5.1:

Replace with: Updated Figure 5.1--Piping & Instrument Diagram (MURR Dwg #156, dated 10/4/95)

Original HSR, Section 8.1, page 8-1, first paragraph, first sentence:

Delete: "The prime purpose of a university . . . ."

Replace with: "The **primary** purpose of a university . . . ."

Original HSR, Section 8.1, page 8-1, first paragraph, last sentence:

Delete: "The result may suffer from certain shortcomings which may be overcome in an AEC test reactor, however, it is possible . . . ."

Replace with: "**The research history of MURR shows** it is possible . . . ."

Original HSR, page 8-2, Section 8.2, paragraph 3, sentence 2:

Delete: "This canister consists of a hollow aluminum tube assembly which is inserted in the center test hole previous to startup."

Replace with: "This canister consists of a hollow aluminum tube **or a triple tube** assembly which is inserted in the **flux trap prior** to startup."

1968 Revision to Original HSR, page 8-2, Section 8.2, paragraph 3:

Delete: "These capsules are originally maintained in their positions by a locking rod latched at the assembly top canister."

Replace with: "These capsules are maintained in their positions by a locking rod **or rods** latched at the assembly top canister."

Original HSR, page 8-2, Section 8.2, paragraph 3, last sentence:

Delete: "The canister has a closure at the top to preclude . . . ."

Replace with: "The canister **top is designed** to preclude . . . ."

Original HSR, page 8-2, Section 8.2, paragraph 4, first sentence:

Delete: "All sample insertions into the flux trap position are subject to review by the reactor supervisor."

Replace with: "All sample insertions into the flux trap position are subject to review by the **Reactor Manager**."

1968 Revision to Original HSR, Section 8.5, pages 8-2 & 8-3, paragraph 4, sentence 2:

Delete: "The reactor shift supervisor will supervise the installation and removal of the canister during shutdown; he will see that either a canister is in place or that a cover is provided over the test hole previous to startup."

Replace with: "**A senior reactor operator** will supervise the installation and removal of the canister during shutdown **and** see that either a canister is in place or that a **strainer** is provided over the test hole **prior** to startup."

Original HSR, page 8-3, Section 8.2, paragraph 6, sentence 2:

Delete "AEC"; Replace with "**NRC**"

Original HSR, page 8-5, Section 8.3, paragraph 2, sentence 1:

Delete: "The prime use of the beamports . . . ."

Replace with: "The **primary** use of the beamports . . . ."

Original HSR, pages 8-5 & 8-6, Section 8.3, paragraphs 4 & 5:

Delete:

"The tangential beamports have been installed to minimize the fast neutron and gamma-ray background. The beamport plug assemblies, which provide shielding for the tangential ports, are identical to those used in the radial ports.

In addition to the expected utilization of the beamports for neutron diffraction or neutron chopper work it is contemplated that a port may occasionally be used in a "loop" type experiment. For this purpose there are available experimental cans mounted as extensions of a modified shield plug. These modified shield plugs have helical conduits through them to admit electrical leads and utility lines to the experimental can. A water line is put through all shield plugs whether the plug is designed for experimental use or shielding. Utilizing this water line it is possible to flood the port when it is not in use or to provide cooling water to an experiment if this is required."

Original HSR, page 8-6, Section 8.3, paragraph 7, sentences 2 & 3:

Delete: "Further, the reactor supervisor will determine if any of the parameters should be used to activate an annunciator and/or the reactor scram system. Spare annunciator positions are available for this purpose."

Replace with: "Further, the Reactor **Manager** will determine if any of the parameters should be used to activate an annunciator and/or the reactor scram system."

Original HSR, page 8-7, Section 8.3, paragraph 11, sentences 3:

Delete: "All ports are closed with a three inch lead . . . ."

Replace with: "All ports **can be** closed with a 3-inch lead . . . ."

Original HSR, page 8-7, Section 8.3, paragraph 11, last sentence:

Delete: "When the port is not in use it may be filled or drained without opening the door by means of a valving system recessed in the floor immediately below each beamport."

Replace with: "When the port is not in use it may be filled or drained without opening the door by means of **an external** valving system **when the reactor is shutdown**."

Original HSR, page 8-8 Section 8.3, 2nd paragraph on page:

Delete: "Within the movable port liner is located the beamport plug. The plug is also closed with a bolt ring and gasket such that the region in front of the plug, or between the end of the plug and the end of the movable port liner, can be flooded with water and, if necessary at higher power, can be water cooled."

Replace with: "Within the movable port liner is located the **collimator liner**. The **collimator liner** is also closed with a bolt ring and gasket such that the region in front of the **collimator liner** and the end of the movable port liner can be flooded with water."

1988 and 1989 Revisions to Original HSR, Section 8.4, page 8-9:

Delete section:

"Irradiation baskets are housed in various elements in the graphite reflector region. There were originally 12 removable graphite elements between Beamports "A" and "F" which could be replaced with irradiation baskets (modified graphite elements to house samples during irradiation at relatively high thermal neutron flux). (rev 1988)

This graphite region has been modified. A large wedge shaped irradiation basket occupies two rows (30°) of the original four row (60°) design. This wedge is an aluminum helium filled structure with six irradiation positions. Two solid aluminum elements, one with a 3 inch O.D. and the other with a 1 inch O.D. irradiation basket, occupy one of the original rows (15°). Two pneumatic tubes terminating in solid aluminum elements and a solid small graphite element occupy the remaining row (15°). (rev 1988)

The remainder of the graphite reflector region (300°) originally consisted of ten (10) 30° wedges (designated elements 1, 2, 3, 4, 5A, 5B, 6, 7, 8, 9) comprised of graphite canned in aluminum. Four of these 30° graphite wedges have been modified to provide irradiation baskets (positions) between Beamport "C" and Beamport "D". The graphite element at position 4 has been replaced with a graphite wedge accommodating both a 2 inch O.D. and a 3 inch O.D. irradiation basket. The graphite elements at positions 5A and 5B have been replaced with elements that each accommodate a 5-1/2 inch O.D. irradiation basket (rev 1989). The graphite element at position 6 has been replaced with an element containing a solid graphite block which provides one 3 inch O.D. irradiation basket and a 1/4 inch I.D. hole to house self-powered neutron detectors (rev 1989). (rev 1988)

All samples that are irradiated are verified to be covered by an approved Reactor Utilization Request (RUR), prepared and scheduled for irradiation by the Reactor Services group. A record is kept of all irradiations. Various forms are utilized based on the type of sample and position required for irradiation. (rev 1988)

Replace section with:

"The graphite reflector region outside the permanent beryllium reflector is made up of removable reflector elements which can be reconfigured to provide sample irradiation positions. These irradiation positions are used to introduce samples of greater size, and for a longer time, into a relatively high thermal neutron flux than would be normal for the pneumatic tube system.

Each of the removable reflector element locations is capable of supporting several types of irradiation samples. Changes in sample irradiation configurations are analyzed for reactor safety, approved by the Reactor Manager, and reviewed by the Safety Subcommittee."

1981-82 Revision to Original HSR, Section 8.5, page 8-10, paragraph 1, sentence 3:

Delete: "The system consists of up to four reactor terminals, up to six sending-receiving stations, two deflector switches, one solenoid cabinet, one turbo-compressor together with the necessary piping, tubing, electrical conduit, and mounting hardware."

Replace with: "The system consists of up to four reactor terminals, up to six sending-receiving stations, two deflector switches, one solenoid cabinet, **two turbo-compressors** together with the necessary piping, tubing, electrical conduit, and mounting hardware. **Currently only two reactor terminals and four sending-receiving stations are used.**"

Original HSR, page 8-11, Section 8.5, paragraph 2, last sentence:

Delete: "Automatic timing is available for periods varying from two seconds to 20 minutes."

Replace with: "Automatic timing is available for periods varying from 2 seconds to **120** minutes."

Original HSR, page 8-11, Section 8.5, paragraph 3, sentence 2:

Delete: "First, two of the pneumatic tubes . . . ."

Replace with: "First, **each** of the pneumatic tubes . . . ."

Original HSR, page 8-12, Section 8.5, paragraph 6, sentence 2:

Delete: "There are four webs each of 0.22 inch thickness with a vertical web cross section, per inch of length, of 0.875 square inches."

Replace with: "There are four webs each of 0.22 inch thickness with a vertical web cross section **of 0.875 square inches per inch of length.**"

Original HSR, Figure 8.1, Beamport Assembly:

Replace with: Updated Figure 8.1, Beamport Assembly (dated 11/15/96)

Original HSR, page 9-12, Section 9.3.3:

Delete section:

"Two identical intermediate range channels are functioning during all phases of reactor operation. The intermediate range neutron detectors are compensated ion chambers mounted in the pool outside the reflector region at approximately core center line elevation in water tight containers. The intermediate range detection locations are variable both vertically and radially.

The compensated ion chambers deliver a d.c. signal proportional to neutron flux to the intermediate range monitor chassis which are mounted on the instrument panel. The intermediate range monitor develops an output which is proportional to the logarithm of ion chamber current. The logarithmic output is delivered to local and remote level indicators and to a recorder. The logarithmic output also drives a period amplifier which delivers a period signal to two independently adjustable trip circuits and to a local and remote period indicator. The remote period and level indicators are located on the control console.

A single intermediate range power level recorder serves both intermediate range monitors. The channel to be recorded is switch selected by the operator at the control console."

Replace with:

"Two intermediate range channels are required to be operable during all phases of reactor operation. The intermediate range neutron detectors may either be compensated ion chambers (CIC) or fission chambers mounted in the pool outside the reflector region at approximately core centerline elevation in water tight drywells. The intermediate range detector locations are designed such that detector locations may be varied both vertically and radially. The compensated ion chamber (CIC) based intermediate range channel delivers a d.c. signal proportional to neutron flux to an intermediate range monitor chassis which is mounted on the instrument panel. The intermediate range monitor develops an output which is proportional to the logarithm of ion chamber current. The logarithmic output is delivered to local and remote level indicators and to a recorder. The logarithmic output also drives a period amplifier which delivers a period signal to two independently adjustable trip circuits and to a local and remote period indicator. The remote period and level indicators are located on the control console.

The fission chamber based intermediate range channel is part of wide range monitor that operates in both the pulse counting mode and the mean-square-voltage (MSV) mode.

The Wide Range signal is a series of randomly spaced pulses superimposed on a d.c. voltage. The pulse signal is processed by one of the log count rate and rate-of-change circuit boards and the d.c. voltage signal is processed by the log amplifier, rate-of-change, and auctioneer circuit board. The log count rate circuit provides an output that is proportional to the logarithm of the average count rate of pulses of the Wide Range signal over the range of about 10^{-8}% to 3 x 10^{-2}% power. The log amplifier circuit provides an output that is proportional to the logarithm of the mean square variation of the Wide Range signal over the range of about five decades, from 10^{-3}% to 200% of reactor power.

The two signals are combined by the auctioneer circuit to provide one continuous output over the range of 10^{-8}% to 200% of reactor power. Two rate-of-change circuits associated with these log signals provide outputs that are also combined to provide one continuous rate-of-change signal over the full reactor flux range. The combined log output and period output are displayed locally on the plasma displays on the front panel and remotely on the control console.

The two intermediate range level indications will be capable of being recorded, although only one IRM level indication is required to be recorded."

Original HSR, Figure 9.6:

Replace with: Updated Figure 9.6--Operating Bridge Plan View (dated 2/7/97)

Original HSR, Figure 10.1:

Replace with: Updated Figure 10.1--Main Reactor Equipment Room (MURR Dwg #2463, Rev. 0)

Original HSR, page 11-11, Section 11.8.3:

Delete: "Daily routines patrols will be established for the mechanical and electrical technician, a reactor operator and the health physicist."

Replace with: "Daily patrols **(Monday - Friday) are** established for a mechanical technician **and a member of the health physics group. Reactor Operations performs routine patrols every day the reactor operates, including weekends and holidays.**"

Original HSR, page 11-12, Section 11.10, list of parameters:

Delete: "Linear power (one of three channels to be selected)."

Replace with: "Linear power"

Original HSR, Section 12:

Delete the following phrases throughout section:

Reactor Supervisor;
Reactor Health Physicist

Replace with:

Reactor Manager;
Reactor Health Physics Manager

Original HSR, page 12-1, Section 12.1; 1982 Annual Report revisions:

Delete:

"The reactor and laboratory facilities will be available to any faculty member or graduate student interested in pursuing research involving radiation, radioisotopes, or the reactor. The diverse research programs initiated will be coordinated and health and safety supervision provided by the permanent staff employed to operate the facilities. The research staff, composed of faculty members and graduate students, will be semi-transient, since no permanent assignment of space or facilities will be made. Administration of the reactor and laboratory will be divorced from the research programs to eliminate the possibility of a compromise in safety for the sake of experimental expediency.

The research reactor facilities staff is divided into two groups. One group, the reactor-operating group, has responsibility for the routine operation and maintenance of the reactor. The second, the laboratory-operations group, has responsibility for the supervision and maintenance of the laboratory facilities associated with the reactor. Coordination and overall administration of these groups is performed by the director of the project. A current table of organization for the Research Reactor Facility based upon continuous operation 7 days a week is presented in Figure 12.1 of this report (rev 1982). It is estimated that the staff requirements for operation of these facilities on an eight-hour day, five-day week, will be twelve to sixteen people. These people will provide operation and supervision of the facilities for all research personnel, expected to number from thirty to sixty people.

The Research Reactor Facility fits within the organizational structure of the University of Missouri as a separate entity."

Replace section with (changes bolded):

"The reactor and laboratory facilities **are** available to faculty **members** or graduate **students** interested in pursuing research involving radiation, radioisotopes, or the reactor. The diverse research programs **are** coordinated and health and safety supervision provided by the permanent staff employed to operate the facilities. **Part of the** research staff, composed of faculty members and graduate students, will be semi-transient, **with** no permanent assignment of space or facilities. Administration of the reactor **is separate** from the research programs to eliminate the possibility of a compromise in safety for the sake of experimental expediency.

The Research Reactor **operations** staff is divided into two groups. One group, the reactor **operations** group, has responsibility for the routine operation and maintenance of the reactor. The second, the **facility** operations group, has responsibility for the supervision and maintenance of the laboratory facilities associated with the reactor. Coordination and overall administration of these groups is performed by the **Facility Director**. A current table of organization for the Research Reactor Facility based upon continuous operation 7 days a week is presented in **Figure 6.0, Technical Specifications**. **The Reactor Operations** staff requirements for operation of these facilities **is expected to** be twelve to sixteen people. These people provide operation and supervision of the facilities for all research personnel.

The Research Reactor Facility fits within the organizational structure of the University of Missouri as **part of the Columbia campus**."

Original HSR, page 12-4, Section 12.2.3:

Add sentence to end of section:

"He will be assisted in the performance of these duties by the Operations Engineer and Reactor Shift Supervisors."

Original HSR, page 12-4, Section 12.2.5, first paragraph:

Delete paragraph 1:

"The Reactor Health Physicist is not part of the Research Reactor Facility Staff. He is responsible to the Radiological safety officer who, in turn, reports to the Dean of Research Administration. The Reactor Health Physicist is permanently housed at the Research Reactor Facility."

Add to beginning of second paragraph:

"The Reactor Health Physics Manager is part of the Research Reactor Facility staff."

Original HSR, page 12-6, Section 12.2.6, paragraph 1, last sentence:

Add the bolded phrase to the end of the sentence:

"During work periods when they are not operating the reactor these individuals will continue their training and will assist in routine maintenance, repair operations, **and sample handling**."

1968 Revision to Original HSR, page 12-7, Section 12.2.7, sentence 2:

Delete: "The shops will be under the direct supervision of the Reactor Supervisor."

Replace with: "The shops will be under the direct supervision of the **Facilities Operations Manager**."

Original HSR, page 12-7, Section 12.3, paragraph 1:

Delete first paragraph which reads:

"The reactor operators will be hired and a teaching and training program completed at the University of Missouri prior to reactor startup. In this manner, these individuals can procure valuable experience in the final construction and installation of machinery, as well as with the electronics associated with the control of the reactor. The machinist and electronic technician will also be trained in the first group of reactor operators to permit them to procure an operator's license so that they might be better prepared to do maintenance on the reactor."

Original HSR, page 12-7, Section 12.3, paragraph 2:

Delete:
"The training program for operators will consist of a series of lectures on reactors, reactor safety, general health physics, reactor control systems, and postulated reactor malfunctions. These lectures will be coupled with a series of experiments which will demonstrate the utilization of health-physics equipment, the operation of components of the reactor systems, and the operation of the reactor controls. This program of training will prepare these people for the A.E.C. operator's license examination."

Replace with (changes bolded):
"The training program for operators will consist of **guided self-study** on reactors, reactor safety, general health physics, reactor control systems, and postulated reactor malfunctions **and emergency response**. **This study** will be coupled with **on-the-job training** which will demonstrate the utilization of health-physics equipment, the operation of components of the reactor systems, and the operation of the reactor controls. This program of training will prepare these people for the **NRC** operator's license examination."

1974 Revision to Original HSR, page 12-7, Section 12.3, paragraph 3:

Delete: "Following licensing by the AEC. . . ."; Replace with: "Following licensing by the **NRC**. . . ."

Original HSR, page 12-8, Section 12.4, paragraph 2, sentences 1 through 4:

Delete: "There will be one afternoon of each week open for visitors between the hours of 1 and 5 p.m. Nontechnical visitors will be guided through the facility by a trained student guide. This guide will be equipped with the normal personnel-monitoring equipment and he will be instructed to stay with the group of 12 to 25 people assigned to him. He will take the group on a preassigned path through the facilities."

Replace with: "Nontechnical visitors will be guided through the facility by trained **guides**. **These guides** will be equipped with the normal personnel-monitoring equipment and he will be instructed to stay with the group of **10 to 15** people assigned to **them**. **They** take the group on a preassigned path through the facilities."

Original HSR, page 12-9, Section 12.4, last paragraph, last two sentences:

Delete: "Technical visitors who have no desire to view the facilities but who wish only to speak to members of the staff or use the library facility, will not be required to have a film badge for intermittent visits. If it is their intent to work in the library or any of the facilities for an extended period of time, they must comply with the established regulations for use of the facilities."

Original HSR, page 12-9, Section 12.5, first paragraph:

Delete:
"The research reactor facilities shall be available for research utilization by any member of the faculties of the University of Missouri and of the universities comprising the Mid-America Association of State Universities. Priorities for the use by the faculty members of any specialized facilities on the reactor shall be established by the simple technique of "who asked first." In the event that questions arise as to the advisability of such a priority assignment, these questions will be negotiated with the Reactor Advisory Committee, and their findings will be final."

Replace with:
"The research reactor facilities shall be available for research utilization by **members** of the **faculty** of the University of Missouri and **other** universities. Priorities for the use of any specialized facilities on the reactor shall be established by the **Facility Director.** In the event that questions arise as to the advisability of a priority assignment, these questions will be **reviewed by** the Reactor Advisory Committee, and their **recommendations made to the Facility Director**."

Original HSR, page 12-10, Section 12.5, paragraph 3, sentence 2 through end of paragraph:

Delete: "Space and radiation facility assignments will be made by the Reactor Supervisor in consultation with the chairman of the graduate student's research committee (or his advisor). Routine irradiations for graduate students who have demonstrated competency in the handling of radioactive materials may be performed without the approval of his faculty advisor."

Replace with: "Space and radiation facility assignments will be made by the Director in consultation with the graduate student's **MURR radiation work supervisor**. Routine irradiations for graduate students who have demonstrated competency in the handling of radioactive materials may be performed **when authorized by the MURR supervisor**."

ADDENDUM 1 - HAZARDS SUMMARY REPORT (FEBRUARY 1966)

HSR, Addendum 1, Item 3.1, page 6, paragraph 10, sentence 1:

Delete: "The control rod drive system will receive a thorough inspection in addition to the rod drop checks following approximately every 4000 hours of operation above 100 KW but not less than once per week."

Replace with: "The control rod drive system will receive a thorough inspection in addition to the rod drop checks."

HSR, Addendum 1, Item 3.1, page 6, paragraph 10:

Add new sentence to end of paragraph:
"Currently each blade is checked once every two years with one blade done every six months."

HSR, Addendum 1, Item 3.11, page 32, paragraph 8, last sentence:

Delete: "The automatic valves on the sixteen inch and six inch ventilation pipes are both quick acting and close in less than one second."

Replace with: "The automatic valves on the 16 inch ventilation pipes are quick acting and close in **about three seconds**."

HSR, Addendum 1, Section 3.17, pages 84 and 85 and first paragraph of page 86:

Delete pages 84 and 85:
"As an illustration of the type of experimentation expected for the beamports consider four experiments presently under construction.

One of the port experiments currently under construction on this campus consists of apparatus for slow neutron scatter studies under the direction of Professor Horace Danner. Considerations which are being made at this time have to do with the shielding of the neutron and gamma radiation penetrating through the collimator. Shielding calculations are being made and collimator design is being dictated partially by these shielding calculations.

Calculations were made and design established for the heat flux generated in the collimator assembly. A part of the collimator consists of an annulus of lead located approximately five feet from the reactor core. It is recognized that this gamma shield, which is surrounded by a cadmium neutron absorber, will undergo some gamma heating. Initially it was planned that this shield would be made of a low melting lead-bismuth alloy. However, calculations showed that the temperature rise in such a material would closely approach the melting point of the material. Lead has been substituted in place of the low melting alloy. The remainder of the materials in this collimator consist of high melting point materials.

Another criteria to which this experiment has been subjected has to do with the voiding of the beamport. When this collimator assembly is not in use the assembly will be flooded with water. To initiate a neutron beam the collimator assembly and beamport will be drained. It will be a part of the low-level calibration work to evaluate the void coefficient of this beamport.

A second beamport experiment consists of a dual beam, triple axis, neutron diffractometer currently on order from Japan. (This unit is identical to that installed at the CP-5 type reactor at Ames, Iowa.) This research program is under the supervision of Dr. Newell Gingrich of the Physics Department. Those criteria having to do with beamport flood and void reactivity measurements and collimator materials and their heat generation are the same in this experiment as in the previous one. This experiment must also be properly shielded. Calculations are being made to determine the requisite shielding for this experiment.

Still a third beamport experiment currently being prepared for insertion in the reactor is one under the direction of Dr. Robert Hurst. This is research having to do with capture gamma-ray measurements. This research group is also constructing a collimator, internal to which there will be an irradiation position where various materials may be subjected to thermal neutron bombardment. The emergent beam, in this instance, will be capture gammas of energies to 10 mev. Criteria applied have to do with reactivity addition on void or flooding of the beamport, heat generation in the collimator materials, and shielding external to the biological shield.

A fourth study currently in design has to do with the measurement of neutron scattering spectrum and is under the direction of Dr. Ed Dowdy of the Nuclear Engineering staff. Again, criteria for review of this experiment have to do with reactivity addition by flood and void of beamport, heat generation in the collimator assembly inserted in the beamport, and shielding external to the biological shield."

Delete first paragraph of page 86:

"In summary it might be said that the criteria applicable to all "in reactor" experiments have to do with reactivity insertion or removal, heat production in the irradiated material, and shielding requirements external to the confines of the reactor pool or the biological shield."

HSR, Addendum 1, Section 3.17, page 86, second paragraph, second and third sentences:

Delete: "Under this general classification one finds the grouping of experimental facilities including the flux trap position, the irradiation baskets, the pneumatic tubes and any in-pool samples external to the reflector. All experiments of this type are subject to review by the reactor supervisor and the reactor health physicist."

Replace with: "Under this general classification one finds the grouping of experimental facilities including the flux trap position, **the graphite reflector positions**, the pneumatic tubes, and any in-pool samples external to the reflector. All experiments of this type are subject to review by the Reactor **Manager** and the Reactor Health Physicist."

HSR, Addendum 1, Section 3.17, page 86, third paragraph, sentence 1:

Delete: "The reactor supervisor critically reviews the proposed experiments to ascertain the reactivity affect, the problem of heat generation, the possibility of sample decomposition, and the general precedence for this type of irradiation."

Replace with: "The Reactor **Manager** critically reviews the proposed experiments to ascertain the reactivity effect, the problem of heat generation, the possibility of sample decomposition, and the general precedence for this type of irradiation **through the review of a Reactor Utilization Request (RUR)**."

HSR, Addendum 1, Section 3.17, page 86, last two sentences of paragraph 3:

Delete: "It is pertinent to point out that samples positioned in the flux trap or in the irradiation baskets will not be moved during reactor operation. Those samples in the pneumatic tube positions will be moved in and out while the reactor is operating."

Replace with: "It is pertinent to point out that samples positioned in the flux trap will not be moved during reactor operation. Those samples in the **graphite reflector and** pneumatic tube positions **may** be moved in and out while the reactor is operating."

HSR, Addendum 1, Section 3.17, page 87, paragraph 1, sentence 1:

Delete: "In any instances where the reactor supervisor feels that he is not qualified to make a judgement pertaining to the safety of a proposed experiment he may refer the experiment to the Reactor Advisory Committee."

Replace with: "In any instances where the Reactor **Manager** feels that he is not qualified to make a judgement pertaining to the safety of a proposed experiment he may refer the experiment to the **appropriate subcommittee of the** Reactor Advisory Committee."

HSR, Addendum 1, Section 3.17, pages 87 and 88:

Delete:

"The charge delivered by the President of the University to the Reactor Advisory Committee reads as follows:

Purpose: The purpose of the Reactor Advisory Committee is to provide to the Research Reactor Facility a body of experts representing a variety of technical disciplines from which advice, counsel and direct assistance relative to matters of safety and experiment design can be drawn.

The Committee shall assist in the determination of priority in the assignment of facility space and time.

The Committee shall assist in the establishment and assessment of facility-use charges.

The Committee shall review procedures pertaining to nuclear and experimental operations.

Certain experiments, as defined by the reactor supervisor. shall be presented to the Reactor Advisory Committee for approval. The final design of the experiments must have the written approval of the Committee.

Meetings: The Committee shall convene normally once each month or at the request of the reactor supervisor. An agenda shall be prepared and distributed prior to each meeting."

Replace with:

"Responsibilities:

The Reactor Advisory Committee is the Committee of the University of Missouri appointed by the University of Missouri-Columbia (UMC) Chancellor to satisfy requirements imposed by the federal government. The University and the Nuclear Regulatory Commission expect this Committee to review and make recommendations concerning experimental and operational activities at the Reactor Facility.

Responsibilities of the Committee are partially set forth in the Technical Specifications portion of the reactor operating license as follows:

1. Review and make recommendations concerning proposed changes to reactor equipment or procedures when such changes have a safety significance, involve an amendment to the operating license including a change in the Technical Specifications, or create an unreviewed safety question as defined by 10 CFR 50.59.
2. Review and make recommendations concerning proposed tests or experiments significantly different from any previously reviewed or which involve an unreviewed safety question as defined by 10 CFR 50.59.
3. Review circumstances of all abnormal occurrences and violations of the Technical Specifications and the remedial measures taken or to be taken to prevent recurrence.

The Committee shall act in an advisory capacity to the Director of the Reactor Facility in matters pertaining to the safe operation of the reactor and with regard to planned research activities and use of the facility building and equipment. It may independently explore policies and procedures as they relate to interaction with other administrative elements of the University and with clients of the Reactor Facility that are not part of the University. It will respond to matters brought before it by the Director, researchers, or other University administrative officials.

The Committee, through its Chairman, may appoint subcommittees consisting of students, faculty, and staff of the University when it is deemed necessary to delegate a part of its responsibilities. Membership on subcommittees need not be limited to appointed members of the Committee. Subcommittees may be authorized to act in behalf of the Committee."

HSR, Addendum 1, Section 3.17, page 88, paragraph 4, sentence 2:

Delete: "First, it is the jury for ascertaining the safety of any experiments which the reactor supervisor or the reactor health physicist feels are subject to question."

Replace with: "First, it is the jury for ascertaining the safety of any experiments which the Reactor **Manager** or the Reactor Health Physicist feel are subject to question."

HSR, Addendum 1, Section 3.17, page 89:

Delete:

"As an indication of the "degree of independence" possessed by the Reactor Advisory Committee it seems logical to enumerate the makeup of this Committee. The name and rank of each Committee member follows:

Duane Fitzgerald - Reactor Supervisor (Executive Secretary)
Clifford Thompson - Assoc. Prof. Physics
Don Gibson - Assoc. Prof. Mechanical Engineering
John L. Cassidy - Assoc. Prof. Civil Engineering
Edward J. Dowdy - Asst. Prof. Nuclear Engineering
Robert L. Carter - Professor Electrical Engineering
Ellis Graham - Professor Soils (Chairman)
Dave Troutner - Assoc. Prof. Chemistry
Doyle R. Edwards - Director, Nuclear Reactor Facility, Rolla, Mo.
J[illegible]an - Radiation Safety Officer
Bob Marriott - Asst. Business Manager & Safety Coordinator
Jim McQuigg - Meteorologist, U.S. Weather Bureau and Research Assoc. in Soils, University of Missouri
Carl Jansen - Resident in Radiology
George Leddicotte - Laboratory Supervisor, Research Reactor Facility

Only one member of the reactor operating staff is a member of this Committee. The reactor supervisor is executive secretary of the Committee. It is felt that in this position he can determine the need for assembling the Committee, he can define the reactor operations, and he can point out questionable experiments to the Committee membership."

HSR, Addendum 1, pages 94-96:

Delete: "laboratory supervisor"

Replace with: "principal experimenter"

ADDENDUM 2 - HAZARDS SUMMARY REPORT (MAY 1966)

HSR, Addendum 2, page 5, last paragraph of page, sentence 2:

Delete: "It will be the function of the reactor staff, the laboratory supervisor, and . . . . "

Replace with: "It will be the function of the reactor staff, the **principal experimenter**, and . . . ."

HSR, Addendum 2, page 6, Reactor Utilization Request form:

At the top of page 6 insert the following note:

"(This is a historical representation of a Reactor Utilization Request (RUR). RURs currently in use include all information asked for in this form, but may include more detailed information and analysis.)"

HSR, Addendum 2, Item 8, page 19, paragraph 3, sentence 1:

Delete: "The air which drives the pneumatic cylinder is delivered through a normally energized solenoid valve."

Replace with: "The air which drives the pneumatic cylinder is delivered through **two** normally energized solenoid **valves**."

HSR, Addendum 2, Item 8, page 19, paragraph 3, sentence 2:

Delete: "These "backup" isolation doors operate only in the event of radiation existing in the ventilation chambers of the east building tower."

Replace with: "These "backup" isolation doors operate in the event of radiation existing in the ventilation chambers of the east building tower **or high radiation levels at the reactor bridge**."

HSR, Addendum 2, Item 8, page 20, paragraph 6, sentences 5 through 7:

Delete: "After a few seconds wait the normal door circuitry will again send the door closed. If the obstruction has cleared, the door will complete the isolation cycle. If not, it will continue to cycle open and close, but will not damage itself."

Replace with: "The door will only close if the operator pushes the button to close the door."

ADDENDUM 3 - HAZARDS SUMMARY REPORT (AUGUST 1972)

HSR, Addendum 3, page 35, Item 2.5.4.2, 1S8 (SBM) Power Level table:

Delete Column 1 heading: ".1 MW"

Replace with: "50 kW"

1995 Revision to HSR, Addendum 3, page 14, Section 2.2.2.10:

Revision stated: "Changed tense from past to present tense."

Should have read: "Changed tense from future to past tense."

1995 Revision to HSR, Addendum 3, page 15, sections 2.2.3.2, 2.2.3.3, 2.2.3.4:

Revision stated: "Changed tense from past to present tense."

Should have read: "Changed tense from future to past tense."

ADDENDUM 4 - HAZARDS SUMMARY REPORT (OCTOBER 1973)

HSR, Addendum 4, Appendix A, Item A.3.14, page A-22, paragraph 2, sentence 1:

Delete: "Bypass switches are utilized to change the protective system to correspond to the three modes of operation (0.1 MW, 5 MW, or 10 MW)."

Replace with: "Bypass switches are utilized to change the protective system to correspond to the three modes of operation (**50 kW**, 5 MW, or 10 MW)."

HSR, Addendum 4, Appendix A, Item A.3.3.4, page A-8, paragraph 1, sentence 1:

Delete: "The period scram channels (NI channels 2 and 3) and the power level scram channels (NI channels 4, 5 and 6) have separate detectors and separate electronics chassis (Refer to section 2.5.2 of Addendum 3 to Hazards Summary Report)."

Replace with: "**The redundant period scram channels (NI Channels 2 and 3) have separate detectors and separate electronics chassis. The redundant power level scram channels (NI Channels, 4, 5 and 6) have separate detectors and separate electronics chassis.** (Refer to section 2.5.2 of Addendum 3 to Hazards Summary Report)."

HSR, Addendum 4, Appendix A, Item A.33.11, page A-13, paragraph 3, sentence 1:

Delete: "At present, all potentially radioactive gases from the pool, pneumatic tube system, beamports, thermal column . . . ."

Replace with: "At present, all potentially radioactive gases from the pool, beamports, thermal column . . . ."

HSR, Addendum 4, Appendix A, Item A.33.11, page A-14, paragraph 3, sentence 7:

Delete: "Control and operation are identical to the present valve, except the new valve is air to open, spring-loaded to close."

Replace with: "Control and operation are identical to the **first** valve, except the **second** valve is air-to-open, spring-loaded to close."

HSR, Addendum 4, Appendix A, Item A.33.11, page A-14, paragraph 3, sentence 9:

Delete: "Air is supplied from the same source as the present valve."

Replace with: "Air is supplied **to both valves from a common source**."

HSR, Addendum 4, Appendix A, Item A.33.11, page A-14, paragraph 3:

Add a new paragraph after paragraph 3:
"The pneumatic tube exhaust is routed through particulate filters directly to the MURR off-gas stack in the west tower. The old 4 inch line in the containment building has been sealed."

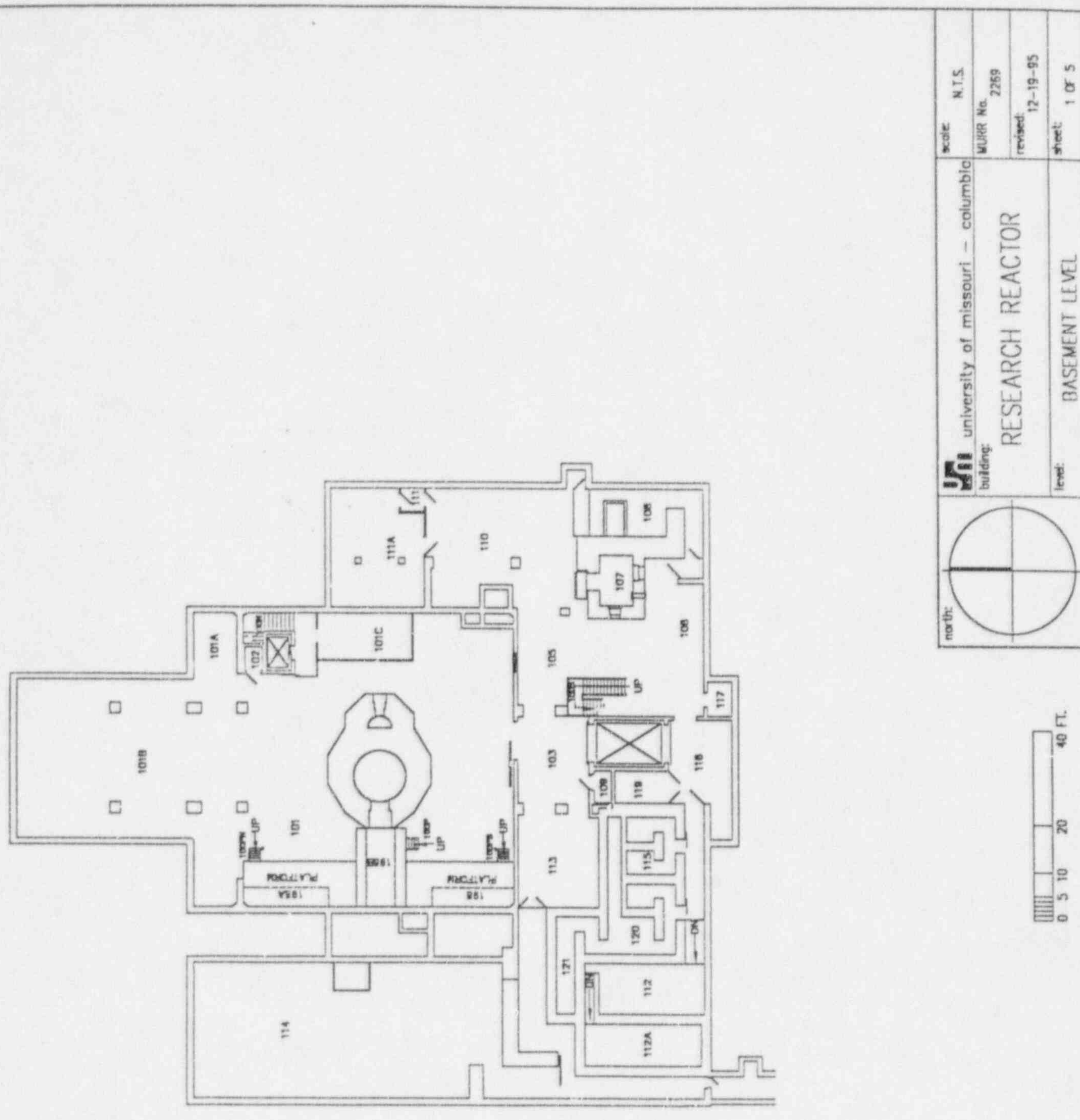


Figure 3.1
Basement Level

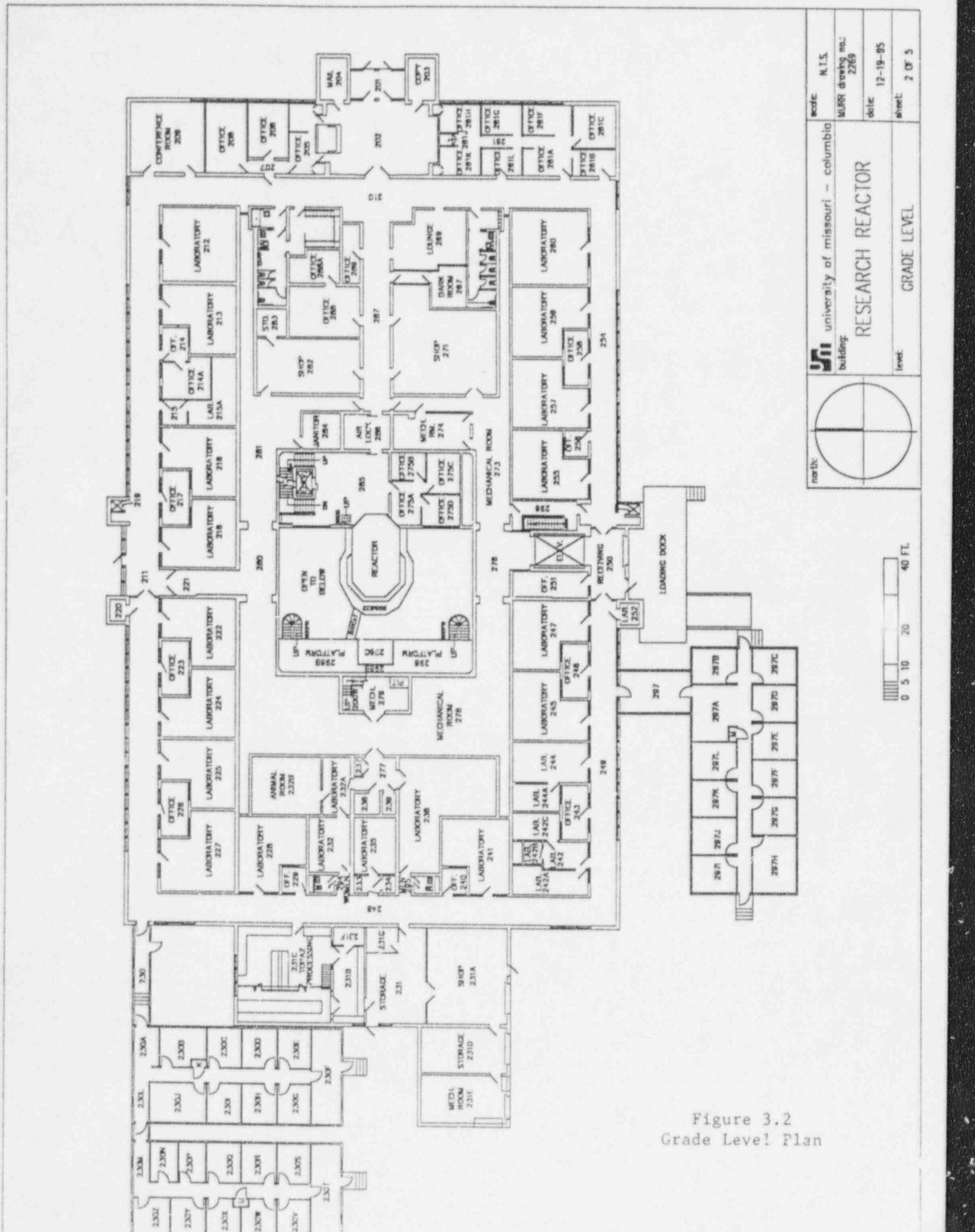


Figure 3.2
Grade Level Plan

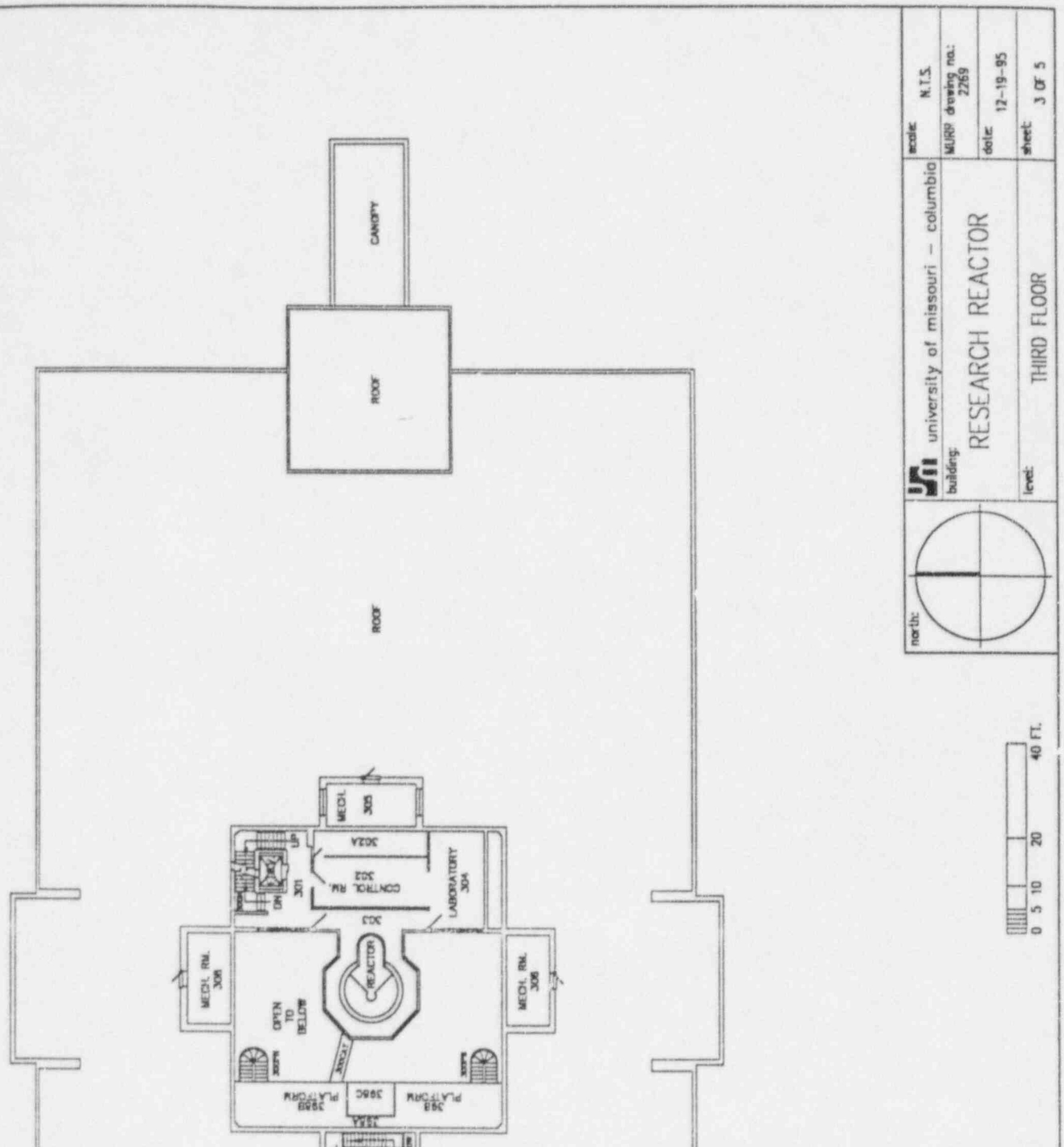


Figure 3.3.a.
Third Floor Plan

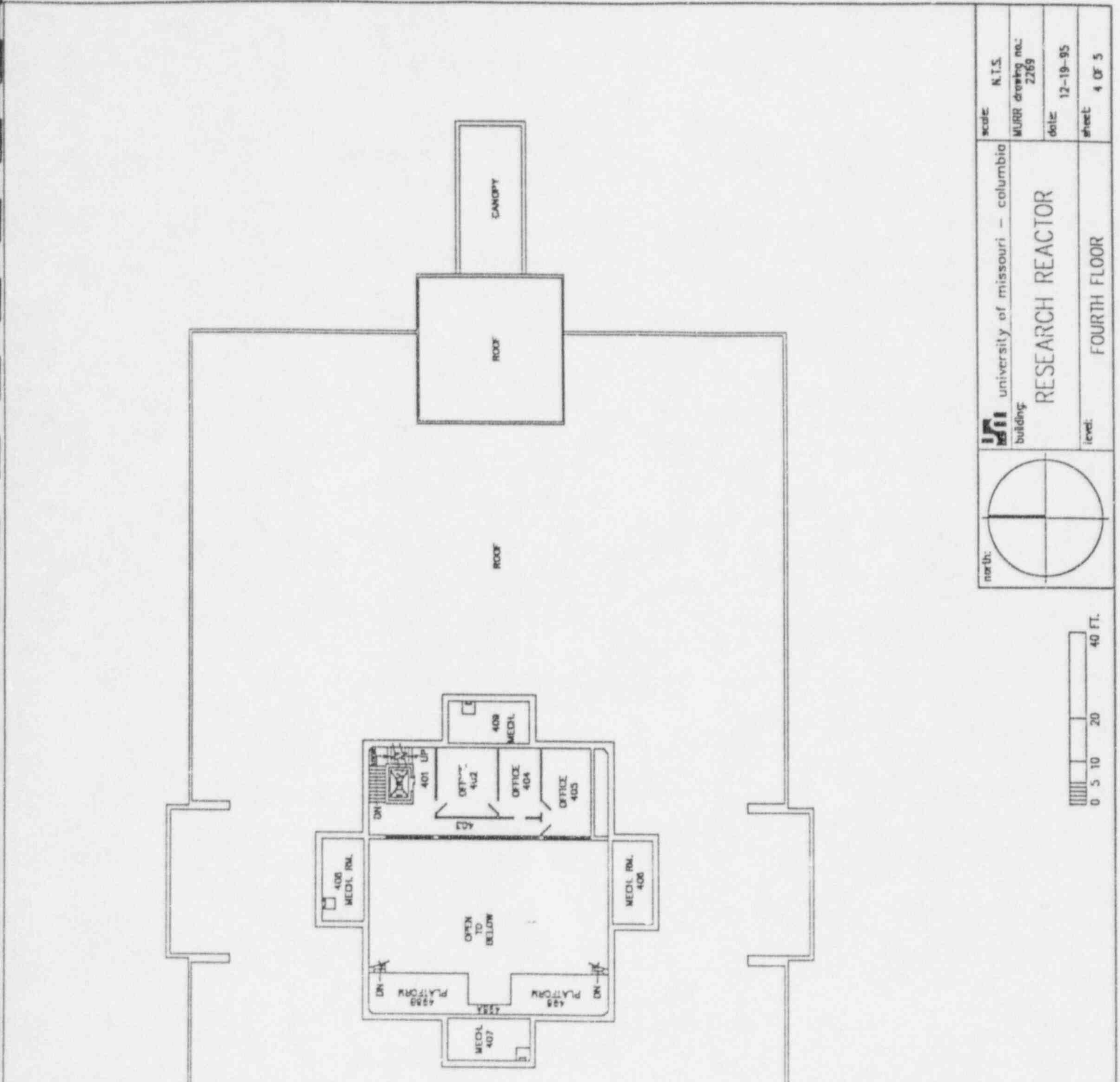


Figure 3.3.b
Fourth Floor Plan

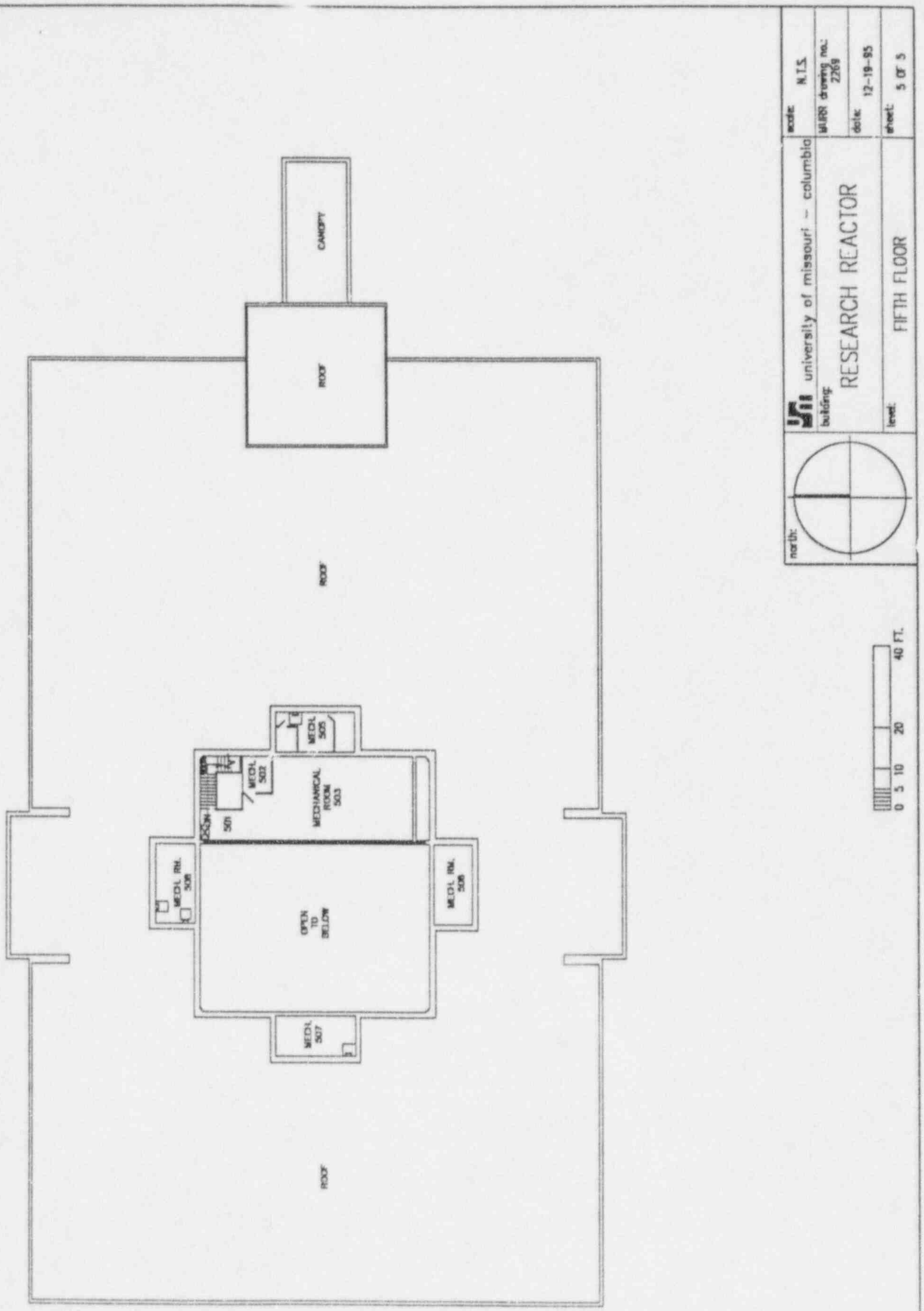


Figure 3.3.c
Fifth Floor Plan

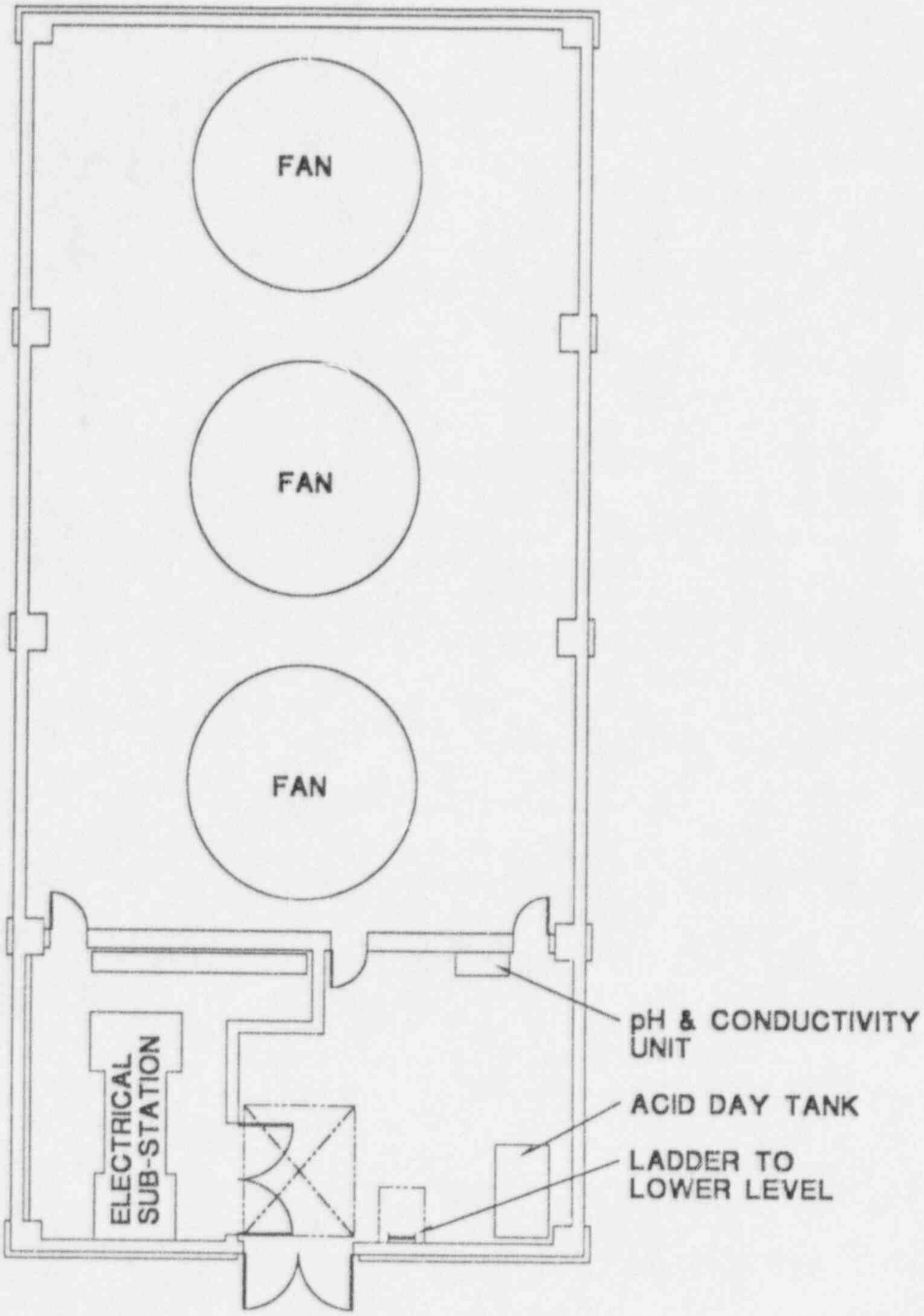
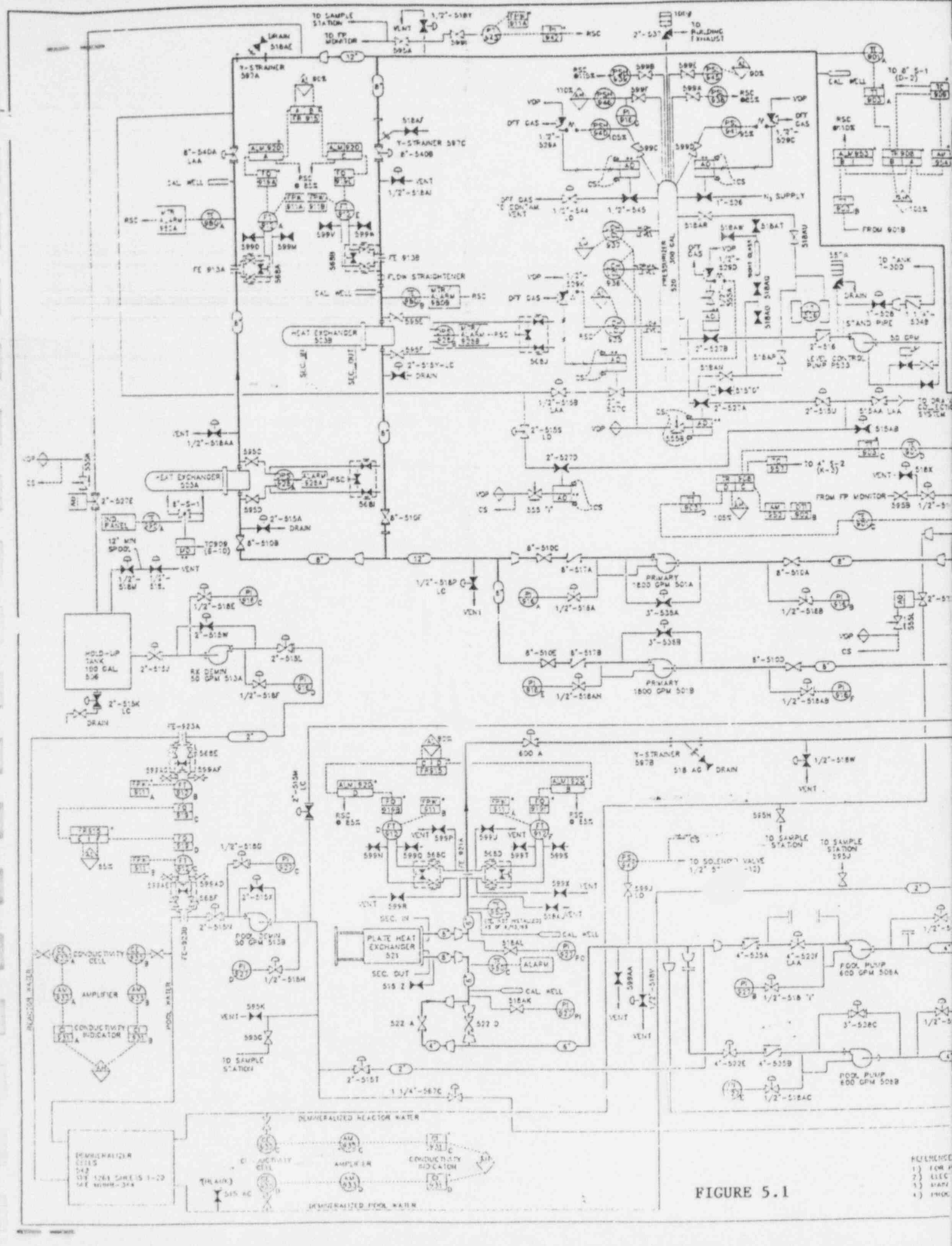


Figure 3.8

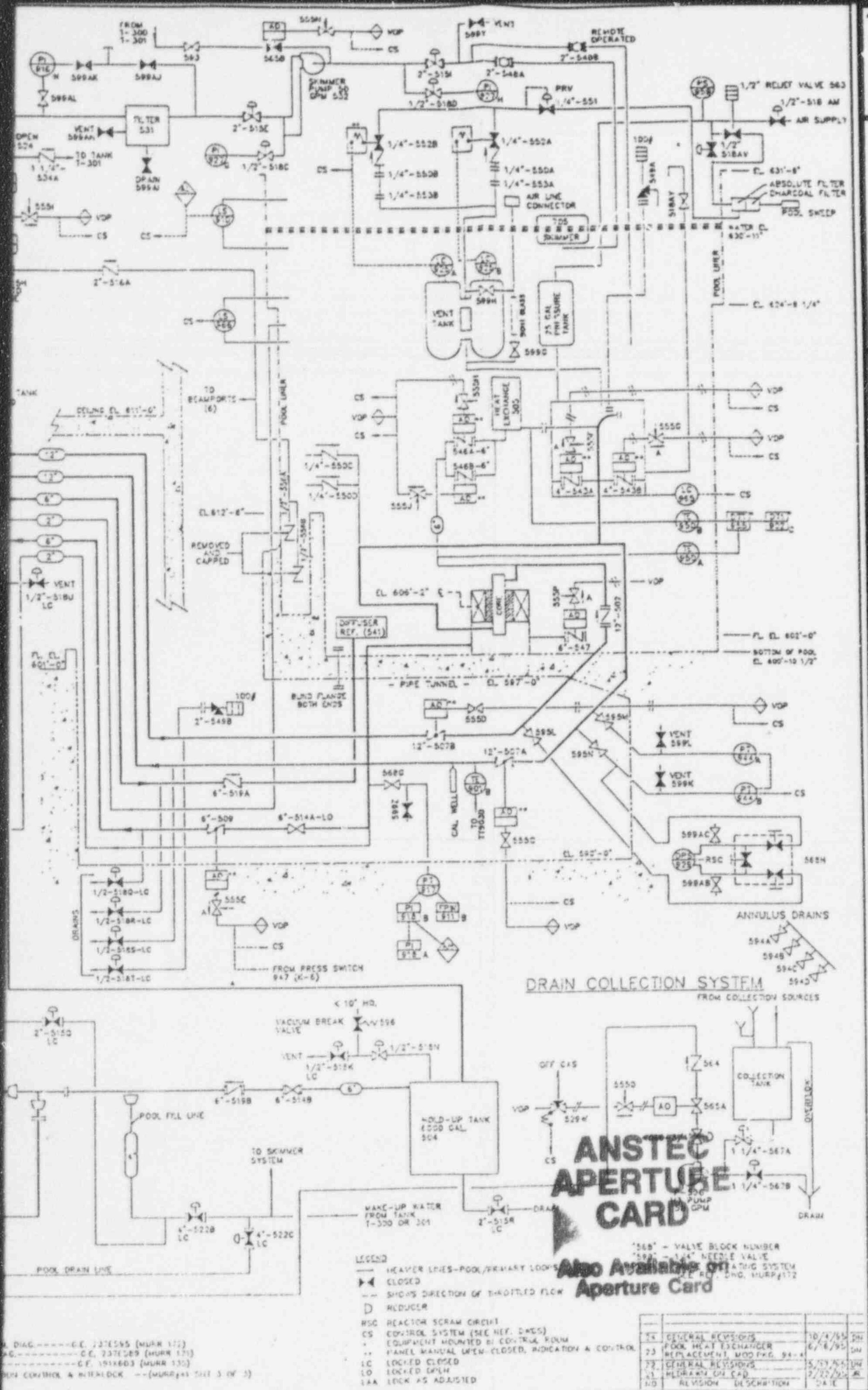
COOLING TOWER AT GRADE LEVEL - PLAN VIEW

(Rev. 5/20/96)



TO SAMPLE STATION
TO FP MONITOR
TO BUILDING EXHAUST
Y-STRAINER 597A
Y-STRAINER 597C
CAL WELL
HEAT EXCHANGER 503B
HEAT EXCHANGER 503A
FLOW STRAIGHTENER
N2 SUPPLY
PRESSURIZER 300 GAL 520
STAND PIPE
LEVEL CONTROL PUMP P533
TO DRAIN COLLECTION SYSTEM
FROM FP MONITOR
PRIMARY 1800 GPM 501A
PRIMARY 1800 GPM 501B
HOLD-UP TANK 100 GAL 506
RX DEMIN 50 GPM 513A
POOL DEMIN 50 GPM 513B
DRAIN
VENT
Y-STRAINER 597B
TO SAMPLE STATION
PLATE HEAT EXCHANGER 521
SEC. IN
SEC. OUT
ALARM
CONDUCTIVITY CELL
AMPLIFIER
CONDUCTIVITY INDICATOR
REACTOR WATER
POOL WATER
POOL PUMP 600 GPM 508A
POOL PUMP 600 GPM 508B
DEMINERALIZED REACTOR WATER
DEMINERALIZED POOL WATER
DEMINERALIZER CELLS
REFERENCE

FIGURE 5.1



DATE:

DRAWN BY: JDR / DGN

CHECKED BY: ENGINEER: CBE

CODE:

REVISION NUMBER: 24

REVISION DATE: 10.4.95

UNIVERSITY OF MISSOURI-COLUMBIA

FACILITIES OPERATIONS

research reactor facility

PIPING & INSTRUMENT DIAGRAM

MURR NUMBER: 156

SHEET 1 of 1

ANSTEC APERTURE CARD

Also Available on Aperture Card

9703070165-1

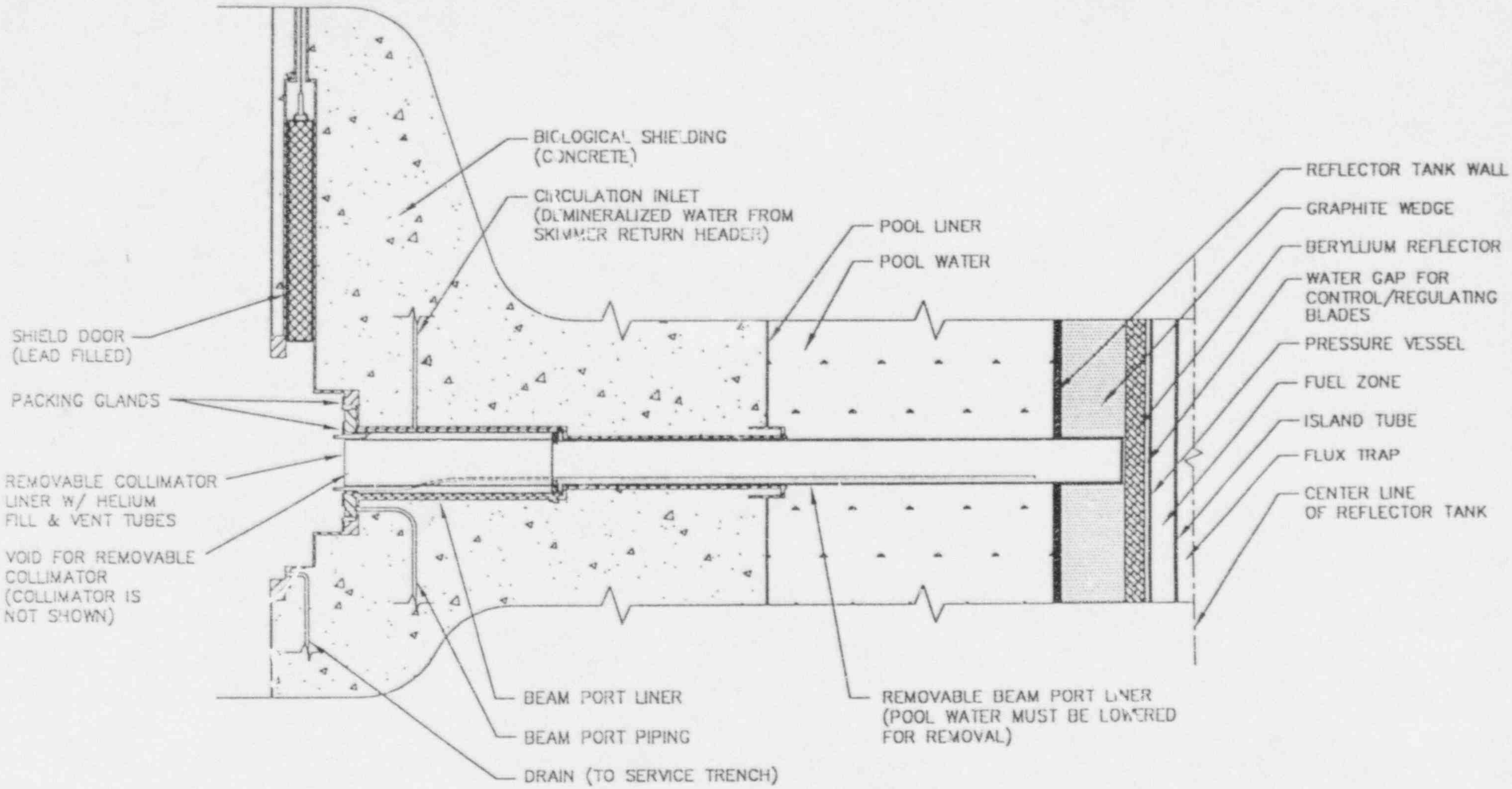
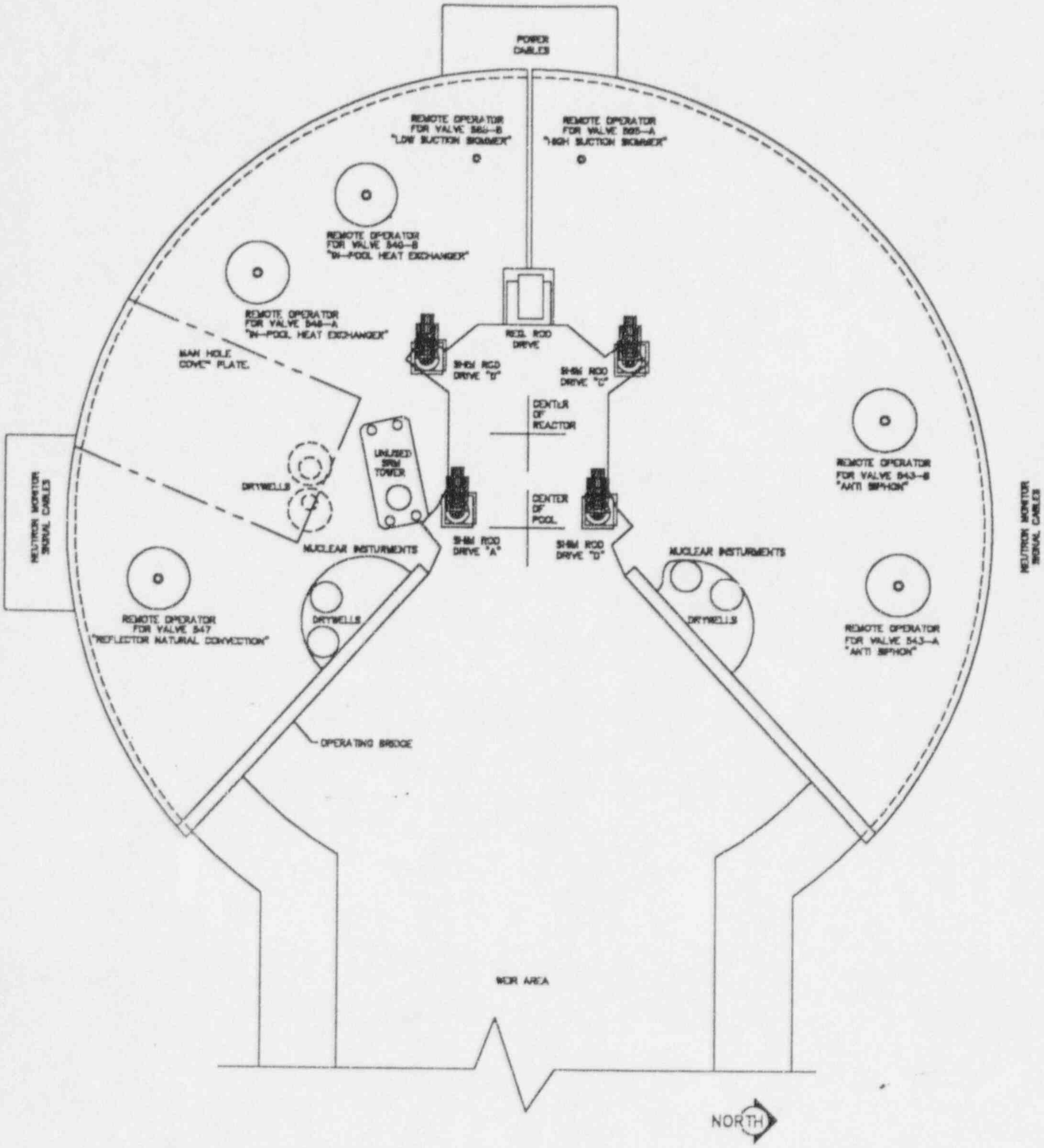


Figure 8.1

SECTION THRU TYPICAL BEAM PORT

(Dated 11/15/96)

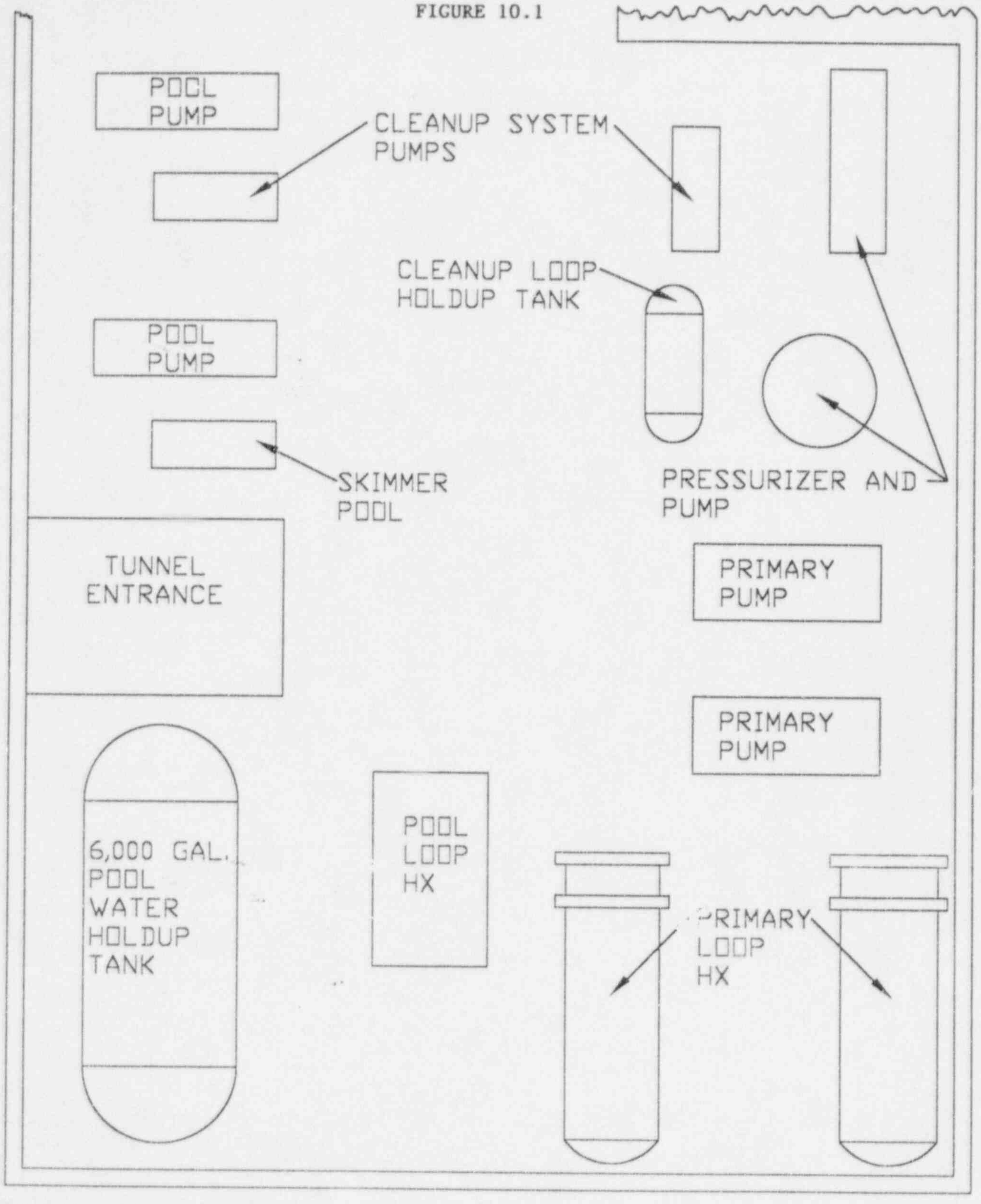
Figure 9.6



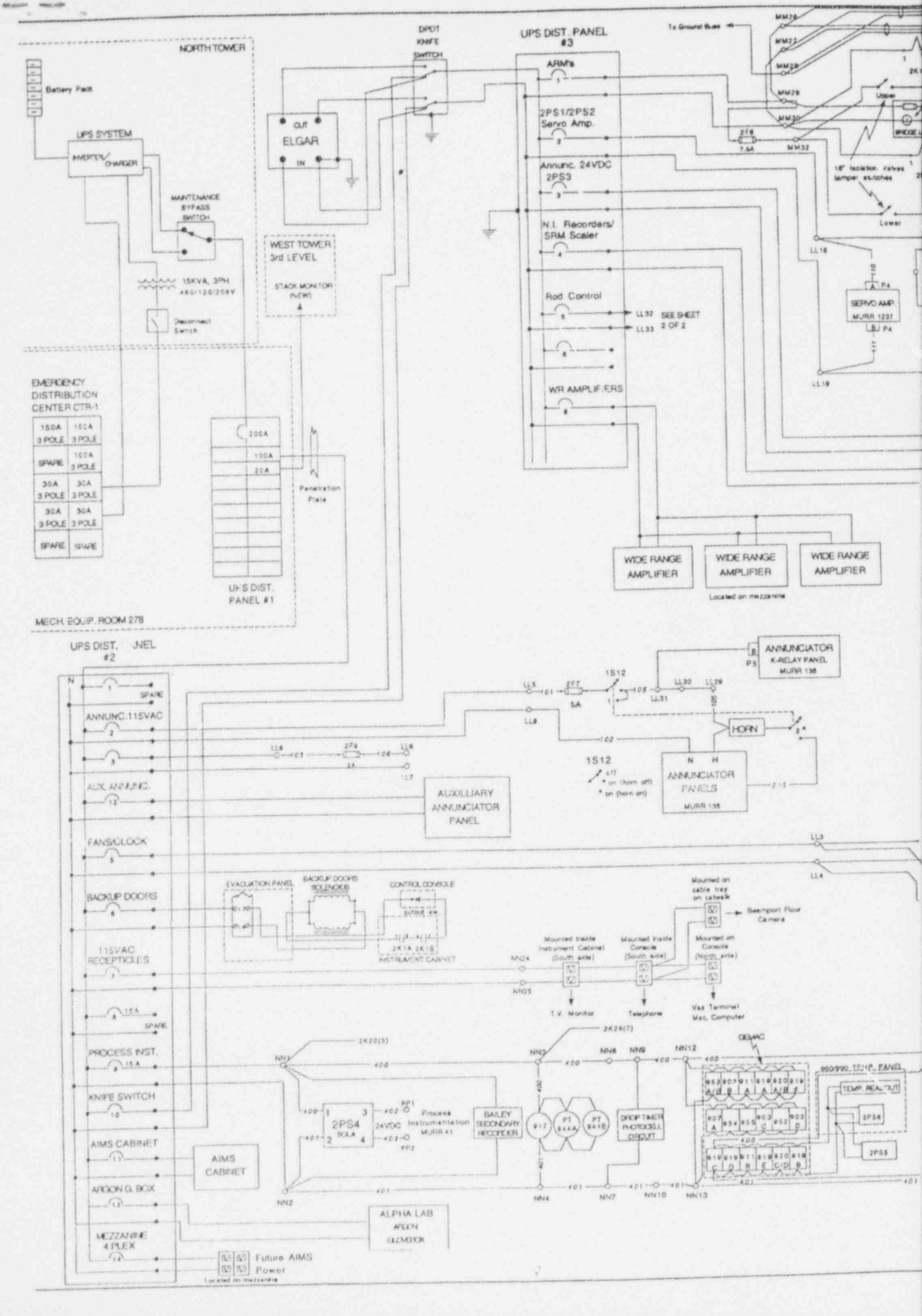
PLAN VIEW - OPERATING BRIDGE

(Rev. 2/7/97)

FIGURE 10.1



MAIN REACTOR EQUIPMENT ROOM	date drawn by J RILEY	murr number 2463
FACILITY OPERATIONS research reactor facility UNIVERSITY OF MISSOURI-COLUMBIA	checked by: engineer code revision 0 rev.date	sheet 1 of 1


NORTH TOWER
Battery Pack
UPS SYSTEM
INVERTER/CHARGER
MAINTENANCE BYPASS SWITCH
15KVA, 3PH 480/120/208V
Disconnect Switch
DPDT KNIFE SWITCH
ELGAR
OUT
IN
WEST TOWER 3rd LEVEL
STACK MONITOR (NEW)
UPS DIST. PANEL #3
ARM's
2PS1/2PS2 Servo Amp.
Annunc. 24VDC 2PS3
N.I. Recorders/ SRM Scaler
Rod Control
LL32
LL33
SEE SHEET 2 OF 2
WR AMPLIFIERS
EMERGENCY DISTRIBUTION CENTER CTR-1
150A 3 POLE
SPARE
100A 3 POLE
30A 3 POLE
SPARE
200A
100A
20A
Penetration Plate
UPS DIST. PANEL #1
MECH. EQUIP. ROOM 278
WIDE RANGE AMPLIFIER
WIDE RANGE AMPLIFIER
WIDE RANGE AMPLIFIER
Located on mezzanine
SERVO AMP. MURR 1237
LL16
LL19
18" isolation valves tamper switches
Upper
Lower
MM26
MM27
MM28
MM29
MM30
MM32
To Ground Buss
UPS DIST. PANEL #2
N
SPARE
ANNUNC.115VAC
AUX. ANNUNC.
FANS/CLOCK
BACKUP DOORS
115VAC RECEPTICLES
SPARE
PROCESS INST.
KNIFE SWITCH
AIMS CABINET
ARGON G. BOX
MEZZANINE 4 PLEX
ANNUNCIATOR K-RELAY PANEL MURR 136
P5
LL5
LL9
LL30
LL29
LL31
2F7
5A
1S12
HORN
ANNUNCIATOR PANELS MURR 136
1S12
off
on (horn off)
on (horn on)
LL6
LL8
LL7
2F9
AUXILLIARY ANNUNCIATOR PANEL
LL3
LL4
EVACUATION PANEL
BACKUP DOORS SOLENOIDS
CONTROL CONSOLE
INSTRUMENT CABINET
2K1A 2K1B
Mounted on cable tray on catwalk
Beamport Floor Camera
Mounted inside Instrument Cabinet (South side)
Mounted inside Console (South side)
Mounted on Console (North side)
NN24
NN25
T.V. Monitor
Telephone
Vax Terminal Mac. Computer
2K22(3)
2K29(7)
NN1
NN3
NN6
NN9
NN12
GEMAC
950/990 TEMP. PANEL
TEMP. READOUT
2PS4
2PS5
2PS4 SOLA
24VDC
PP1
PP2
Process Instrumentation MURR 41
BAILEY SECONDARY RECORDER
917
PT 944A
PT 941B
DROP TIMER PHOTOCELL CIRCUIT
NN2
NN4
NN7
NN10
NN13
AIMS CABINET
ALPHA LAB ARGON GLOVEBOX
Future AIMS Power
Located on mezzanine

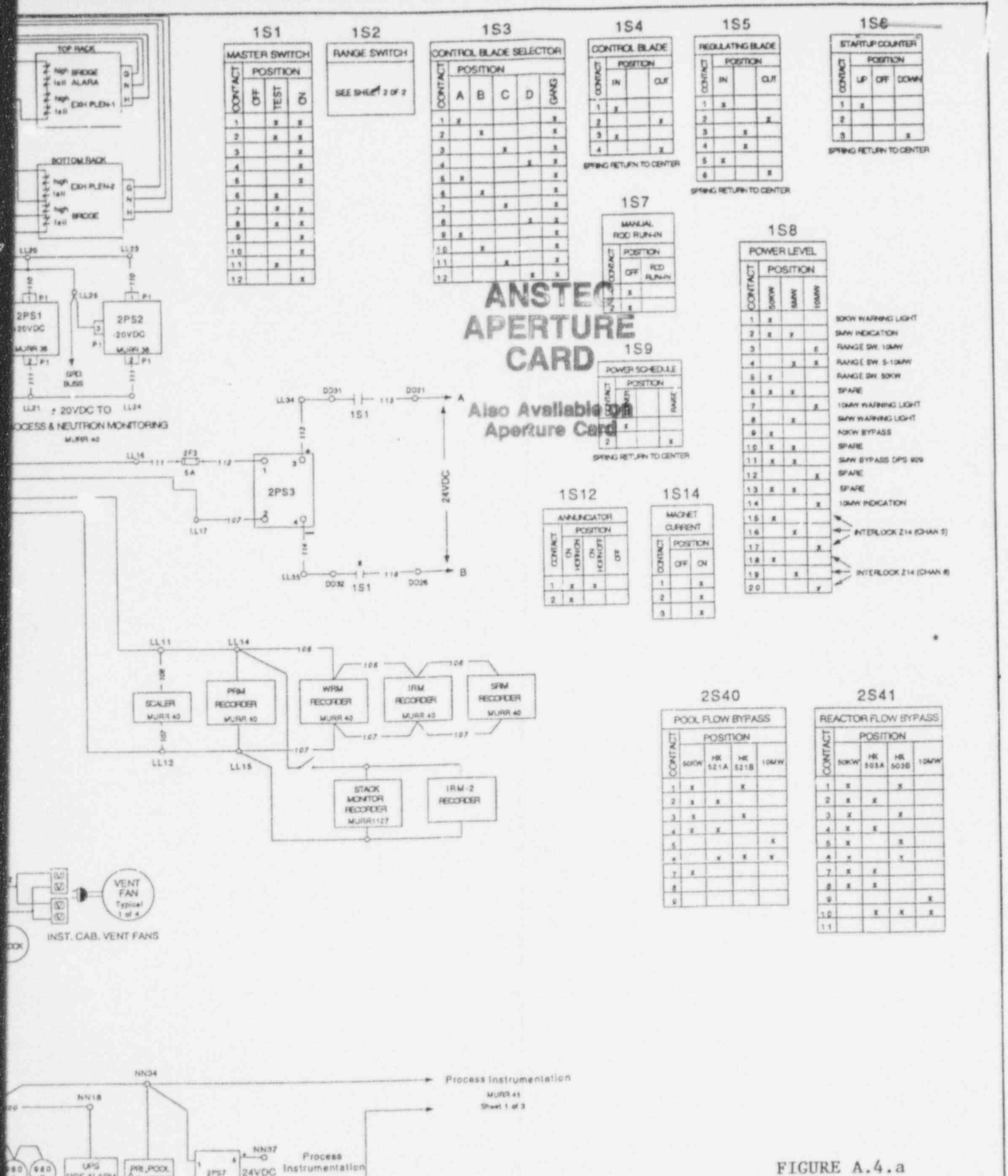


FIGURE A.4.a

REVISIONS

NO.	DESCRIPTION	Init.	DATE
29	Added AIMS Cab, Aux. Annunc, Mezzanine 4 plex G.M. Amplifiers and IRM-2 Rec. Remove FC drive	THS	12/19/96
28	Added Title block, arranged drawing to fit	THS	12/16/92
27	Added ARM's & Backup Door Ckts.	THS	

TITLE
REACTOR CONTROL SYSTEM

RESEARCH REACTOR FACILITY
UNIVERSITY OF MISSOURI

DRAWN BY THS | APPROVED | DATE 9/30/92
SHEET NO. 1 OF 2 | DWG. NO. 42

9703070165-2

SECTION IV

PLANT AND SYSTEM MODIFICATIONS

1 January 1996 through 31 December 1996

The safety evaluation for each modification described below is on file at MURR and documents that it does not present an unreviewed safety question as per 10 CFR 50.59.

Modification 95-3: Relocation of pneumatic tube to south side of reflector

This modification package documents the relocation of the pneumatic tubes from north side graphite reflector region to south side reflector region, graphite wedge number 3.

Modification 96-1: Removal of Nuclepore gas lines, isolation valves and valve control wiring

This modification documents the removal and capping of Nuclepore gas lines and isolation valves. Nuclepore was a fueled experiment which has been removed from service and the reactor. The isolation valves and control wiring were part of the reactor isolation system.

SECTION V

NEW TESTS AND EXPERIMENTS

1 January 1996 through 31 December 1996

Addendum to RUR-219:

This addendum authorized small diameter seal-welded samples to be run inside standard size "flooded" sample cans for flux trap irradiations. These "flooded" cans provide the mechanical support to keep the smaller diameter samples rigidly fixed within the can, but allows water contact to the surface of the smaller diameter samples.

The use of "flooded" cans is limited to small diameter seal-welded samples that can retain the same number of barriers (e.g., double or single encapsulation) to the release of contents as evaluated in target specific Reactor Utilization Requests (RURs)

A number of beamport floor experimental equipment upgrades are nearing completion that are part of a class of experiments previously evaluated and do not involve an unreviewed safety question as per 10 CFR 50.59.

SECTION VI

SPECIAL NUCLEAR MATERIAL ACTIVITIES

1 January 1996 through 31 December 1996

1. SNM Receipts: A total of 24 new fuel elements were received from Babcock and Wilcox (B & W), Lynchburg, Virginia.

Shipper	Elements	Grams U	Grams U-235
B & W	MO-453, MO-454, MO-455, MO-456, MO-457, MO-458, MO-459, MO-460, MO-461, MO-462, MO-463, MO-464, MO-465, MO-466, MO-467, MO-468, MO-469, MO-470, MO-471, MO-472, MO-473, MO-474, MO-475, MO-476	19,944	18,575

2. SNM Shipments: A total of 16 spent fuel elements were shipped to DOE facilities at Savannah River Plant, Aiken, South Carolina.

Shipper	Elements	Grams U	Grams U-235
MURR	MO-377, MO-379, MO-382, MO-384, MO-385, MO-386, MO-387, MO-388, MO-389, MO-390, MO-391, MO-392, MO-394, MO-396, MO-402, MO-404	11,253	9,948

3. Inspections: None.

4. SNM Inventory: As of 31 December 1996, MURR was financially responsible for the following DOE-owned amounts:

   Total U = 58,240 grams

   Total U-235 = 51,993 grams

   Included in these totals are 36 grams of U and 34 grams of U-235 in DOE-owned non-fuel. In addition to these totals, MURR owns 171 grams of U and 90 grams of U-235. All of this material is physically located at the MURR.

The fuel elements on hand have accumulated the following burn-ups as of 31 December 1996.

Burned-up Elements (28)

Element No.	MWD	Element No.	MWD	Element No.	MWD
MO-393	123.264	MO-407	116.854	MO-417	134.856
MO-395	123.264	MO-408	138.484	MO-418	133.286
MO-397	122.151	MO-409	133.083	MO-419	132.195
MO-398	118.747	MO-410	134.506	MO-420	132.195
MO-399	122.151	MO-411	133.083	MO-421	138.741
MO-400	118.747	MO-412	134.506	MO-422	138.384
MO-401	139.760	MO-413	134.876	MO-423	138.741
MO-403	139.760	MO-414	134.856	MO-424	138.884
MO-405	116.854	MO-415	134.876		
MO-406	138.484	MO-416	133.286		

Elements in Service (52)

MO-425	134.615	MO-443	93.718	MO-461	87.058
MO-426	118.692	MO-444	96.724	MO-462	75.417
MO-427	134.615	MO-445	103.949	MO-463	87.058
MO-428	118.692	MO-446	95.176	MO-464	75.417
MO-429	112.257	MO-447	103.949	MO-465	71.119
MO-430	104.517	MO-448	95.176	MO-466	54.285
MO-431	112.257	MO-449	103.975	MO-467	71.119
MO-432	104.517	MO-450	94.128	MO-468	54.285
MO-433	96.415	MO-451	103.975	MO-469	37.376
MO-434	95.224	MO-452	94.128	MO-470	9.595
MO-435	96.415	MO-453	104.871	MO-471	37.376
MO-436	95.224	MO-454	90.060	MO-472	9.595
MO-437	90.972	MO-455	104.871	MO-473	2.045
MO-438	89.843	MO-456	90.060	MO-474	0.000
MO-439	90.972	MO-457	91.114	MO-475	2.045
MO-440	89.843	MO-458	84.611	MO-476	0.000
MO-441	93.718	MO-459	91.114		
MO-442	96.724	MO-460	84.611		

Average Burn-up (all elements): 99.44 MWD

SECTION VII

REACTOR PHYSICS ACTIVITIES

1 January 1996 through 31 December 1996

1. Fuel Utilization: During the period 1 January 1996 through 31 December 1996, the following elements reached feasible burn-up and were retired:

Serial Number	Final Core	Date Last Used	MWD
MO-401	96-10	03-04-96	140
MO-403	96-10	03-04-96	140
MO-406	96-13	03-25-96	138
MO-408	96-13	03-25-96	138
MO-409	96-28	06-24-96	133
MO-410	96-33	07-29-96	134
MO-411	96-28	06-24-96	133
MO-412	96-33	07-29-96	134
MO-413	96-38	09-03-96	125
MO-414	96-19	04-29-96	135
MO-415	96-38	09-03-96	135
MO-416	96-18	04-22-96	133
MO-417	96-19	04-29-96	135
MO-418	96-18	04-22-96	133
MO-419	96-27	06-17-96	132
MO-420	96-27	06-17-96	132
MO-421	96-43	10-07-96	139
MO-422	96-50	11-25-96	139
MO-423	96-43	10-07-96	139
MO-424	96-50	11-25-96	139

Due to the requirement of having less than 5 kg of unirradiated fuel in possession, initial criticalities are obtained with four new elements or fewer as conditions dictate. A core designation consists of eight fuel elements of which only the initial critical fuel element serial numbers are listed in the following table of elements in service 31 December 1996. To increase operating efficiency, fuel elements are used in mixed core loadings. Therefore, a fuel element fabrication core number is different from its core load number.

Serial Number	Fabrication Core Number	Initial Core Load Number	Initial Operating Date
MO-449	68	96-1	01-02-96
MO-450	69	96-3	01-16-96
MO-451	69	96-1	01-02-96
MO-452	69	96-3	01-16-96
MO-453	69	96-4	01-22-96
MO-454	69	96-13	03-18-96
MO-455	69	96-4	01-22-96
MO-456	69	96-13	03-18-96
MO-457	70	96-14	03-25-96
MO-458	70	96-21	05-06-96
MO-459	70	96-14	03-25-96
MO-460	70	96-21	05-06-96
MO-461	70	96-24	05-20-96
MO-462	70	96-32	07-15-96
MO-463	70	96-24	05-20-96
MO-464	70	96-32	07-15-96
MO-465	71	96-34	07-29-96
MO-466	71	96-43	09-30-96
MO-467	71	96-34	07-29-96
MO-468	71	96-43	09-30-96
MO-469	71	96-47	10-28-96
MO-470	71	96-55	12-23-96
MO-471	71	96-47	10-28-96
MO-472	71	96-55	12-23-96
MO-473	72	96-56	12-30-96
MO-475	72	96-56	12-30-96

2. Fuel Shipments: Sixteen spent fuel elements were shipped from MURR to Savannah River Site, Aiken, South Carolina. The identification numbers of these elements are:

   MO-377, MO-379, MO-382, MO-384, MO-385, MO-386, MO-387, MO-388, MO-389, MO-390, MO-391, MO-392, MO-394, MO-396, MO-402, MO-404

3. Fuel Procurement: Babcock and Wilcox, Lynchburg, Virginia, is MURR's fuel assembly fabricator. This work is contracted with the U.S. Department of Energy and administered by EG&G Idaho Inc., Idaho Falls, Idaho. As of 31 December 1996, 277 fuel assemblies fabricated by B & W had been received and 275 used in cores at 10 MW.

4. Licensing Activities: On March 15, 1995, the Nuclear Regulatory Commission approved Amendment No. 28 to the facility operating license R-103. This amendment temporarily increased the Special Nuclear Material inventory limit to 75 kg U-235 to May 31, 1997, pending the completion of spent fuel shipments. This amendment also authorized possession of up to 60 kg of U-235 without an expiration date.

Amendment 28 requires that this annual report include the status of spent fuel shipments. Two shipments of eight fuel elements each were completed in 1996, and four such shipments are scheduled in 1997. MURR staff continue their efforts to achieve more regular acceptance of spent fuel at Savannah River Plant with limited success. The Department of Energy has to contend with the spent fuel needs of university research reactors, DOE reactors, and with the receipt and storage of foreign fuel. This has lead to uncertainty and continuing changes to our spent fuel shipping opportunities.

A request for a unique purpose exemption as defined in 10 CFR 50.2 was submitted September 26, 1986, and is pending.

5. Reactor Characteristic Measurements: Fifty-six refueling evolutions were completed. An excess reactivity verification was performed for each refueling and the average excess reactivity was 1.90%. The largest excess reactivity was 2.41%. MURR Technical Specification 3.1(f) requires that the excess reactivity be less than 9.8%.

Reactivity measurements were performed for five evolutions to verify reactivity parameters for the flux trap. Three differential worth measurements were made on shim blades. One differential worth measurement was made on the regulating blade.

SECTION VIII

RADIOACTIVE EFFLUENT

1 January 1996 through 31 December 1996

TABLE 1

SANITARY SEWER EFFLUENT

1 January 1996 through 31 December 1996

Descending Order of Activity Released for Nuclide Totals > 1.00E-05 Ci

Nuclide	Activity (Ci)
H-3	1.487E-01
S-35	3.764E-03
Ca-45	1.724E-03
Co-60	9.962E-04
Zn-65	5.608E-04
As-77	3.546E-04
Re-186	3.855E-05
Cd-109	2.950E-05
Re-188	2.621E-05
Nb-95	2.358E-05
Cr-51	1.743E-05
Total H-3	**1.487E-01**
Total Other	**7.534E-03**

TABLE 2

STACK EFFLUENT

1 January 1996 through 31 December 1996

Ordered by % Technical Specification (TS) Limit

Isotope	Average Concentration µCi/ml	Total Release 1/96 - 12/96 (Ci)	TS Limit Multiplier	% TS*
Ar-41	1.62E-06	7.28E+02	350	46.2632
Cd-109	1.32E-13	5.94E-05	1	0.1889
Hg-203	1.48E-12	6.67E-04	1	0.1484
I-131	2.93E-13	1.32E-04	1	0.1467
H-3	2.50E-08	1.12E+01	350	0.0715
Zn-65	2.69E-14	1.21E-05	1	0.0067
Ce-144	1.29E-15	5.81E-07	1	0.0065
Se-75	4.85E-14	2.18E-05	1	0.0061
S-35	1.60E-13	7.20E-05	1	0.0053
Cs-137	1.01E-14	4.54E-06	1	0.0050
Co-60	1.45E-15	6.50E-07	1	0.0029
Eu-155	4.21E-15	1.89E-06	1	0.0021
Sc-46	4.57E-15	2.05E-06	1	0.0015
Os-191	8.98E-15	4.04E-06	1	0.0004
Cd-115	6.28E-15	2.82E-06	1	0.0003
I-133	1.08E-12	4.87E-04	350	0.0003
Cl-38	4.00E-11	1.80E-02	350	0.0002
Ce-141	1.16E-15	5.22E-07	1	0.0001
Ce-139	1.27E-15	5.73E-07	1	0.0001
Br-82	1.99E-12	8.93E-04	350	0.0001
Pa-233	9.04E-16	4.06E-07	1	0.0001
I-135	2.12E-12	9.54E-04	350	0.0001
Total				**46.8568**

*Isotopes observed at <0.0001 % TS limit are not listed.

Stack flow rate = 30,198 cfm

SECTION IX

ENVIRONMENTAL MONITORING AND HEALTH PHYSICS SURVEYS

1 January 1996 through 31 December 1996

Environmental samples are collected two times per year at eight locations and analyzed for radioactivity. The sampling 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. Analytical results are shown in Tables 1 and 2.

Table 3 lists the radiation doses recorded by environmental monitors deployed around MURR in 1996. All doses are about 50 mrem/year or less, except monitor numbers 9 and 15. These monitors are located near the loading dock where packages containing radioactive material are loaded on transport vehicles. The doses recorded by these monitors are considered to be the result of exposure to packages in transit.

The number of radiation and contamination surveys performed each month are provided in Table 4.

Table 1
Summary of Environmental Set 49
April 1996

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	1.83pCi/l	2.36 pCi/l	204.12 pCi/l	9.96 pCi/ml of sample
Soil	1.4 pCi/g	2.18 pCi/g	1.27 pCi/g	N/A
Vegetation	2.8pCi/g	4.36 pCi/g	4.54 pCi/g	7.87 pCi/ml of distillate

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

Activity Levels -- Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
10V49	< 2.8	< 4.36	< 4.54	< 7.87
1V49	< 2.8	5.60	< 4.54	< 7.87
2V49	< 2.8	< 4.36	< 4.54	< 7.87
3V49	< 2.8	< 4.36	< 4.54	< 7.87
4V49	< 2.8	< 4.36	< 4.54	< 7.87
5V49	< 2.8	< 4.36	4.92	< 7.87
6V49	< 2.8	< 4.36	5.00	< 7.87
7V49	< 2.8	< 4.36	< 4.54	< 7.87

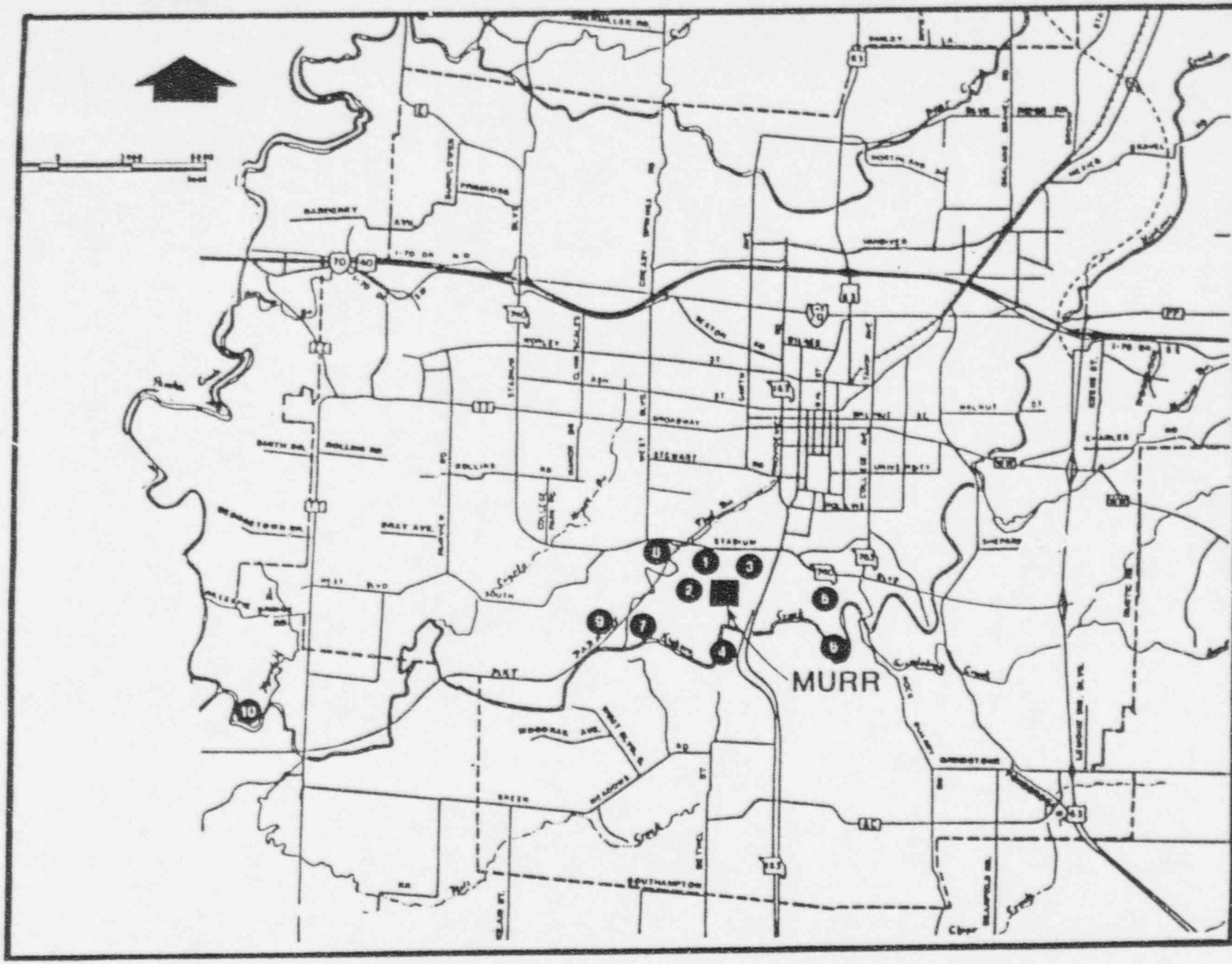


Figure 1. MURR Environmental Program Sample Stations

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.

Activity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S49	< 1.4	< 2.18	5.16
1S49	< 1.4	2.68	7.14
2S49	< 1.4	2.19	4.87
3S49	< 1.4	< 2.18	4.20
4S49	< 1.4	< 2.18	3.47
5S49	< 1.4	2.75	5.39
6S49	< 1.4	< 2.18	4.60
7S49	< 1.4	2.33	6.19

Activity Levels -- Water

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
10W48	< 1.83	3.70	< 204.12	< 9.96
4W48	< 1.83	< 2.86	< 204.12	< 9.96
6W48	< 1.83	< 2.86	< 204.12	< 9.96

Table 2
Summary of Environmental Set 50
October 1996

Detection Limits*

Matrix	Alpha	Beta	Gamma	Tritium
Water	0.73 pCi/l	2.49 pCi/l	210.63 pCi/l	2.62 pCi/ml of sample
Soil	0.65pCi/g	2.22 pCi/g	1.55 pCi/g	N/A
Vegetation	1.3 pCi/g	4.44 pCi/g	3.05 pCi/g	2.62 pCi/ml of distillate

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

Activity Levels -- Vegetation

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)	H-3 (pCi/ml)
10V48	< 1.30	4.70	< 3.05	< 2.62
1V48	< 1.30	9.11	< 3.05	< 2.62
2V48	< 1.30	< 4.44	< 3.05	< 2.62
3V48	< 1.30	< 4.44	< 3.05	< 2.62
4V48	< 1.30	8.23	< 3.05	< 2.62
5V48	< 1.30	4.55	< 3.05	< 2.62
6V48	< 1.30	< 4.44	< 3.05	< 2.62
7V48	< 1.30	4.85	< 3.05	< 2.62

Activity Levels -- Soil

Sample	Alpha (pCi/g)	Beta (pCi/g)	Gamma (pCi/g)
10S48	< 0.65	4.64	6.30
1S48	< 0.65	2.97	6.95
2S48	< 0.65	2.95	6.02
3S48	< 0.65	2.64	5.58
4S48	< 0.65	< 2.22	3.74
5S48	< 0.65	3.15	6.92
6S48	< 0.65	2.26	3.98
7S48	< 0.65	2.68	5.28

Activity Levels -- Water

Sample	Alpha (pCi/l)	Beta (pCi/l)	Gamma (pCi/l)	H-3 (pCi/ml)
10W48	< 0.73	4.70	< 210.63	< 2.62
4W48	< 0.73	4.91	< 210.63	< 2.62
6W48	< 0.73	< 2.49	< 210.63	< 2.62

Table 3
Environmental TLD Summary*
1 January 1996 through 31 December 1996

Badge Number	Direction From MURR	Map Distance from MURR Stack (meters)	1st Qtr. 1996 Net mR	2nd Qtr. 1996 Net mR	3rd Qtr. 1996 Net mR	4th Qtr. 1996 Net mR	Total 1996 Net mR
1	Various	N/A	-3.6	1.3	0.1	-3.1	-5.3
2	Various	N/A	-4.7	1.8	-1.8	-0.4	-5.1
3	Various	N/A	1.8	6.1	8.6	5.5	22.0
4	Various	N/A	-2.9	-0.5	-0.5	-0.6	-4.5
5	Various	N/A	-2.2	0.7	-1.0	-0.3	-2.8
6	N	34	5.5	12.2	7.0	4.5	29.2
7	NE	57	6.9	10.6	9.1	8.3	34.9
8	SW	27	8.4	7.4	0.8	5.7	22.3
9	S	27	40.4	63.0	64.1	53.5	221.0
10	NE	149	-1.4	0.3	0.0	0.3	-0.8
11	NW	149	-0.2	4.0	2.4	2.6	8.8
12	ENE	301	1.2	6.4	2.3	4.0	13.9
13	NNE	316	0.2	6.3	2.9	2.1	11.5
14	S	156	1.5	7.4	3.4	4.8	17.1
15	S	65	15.4	19.7	15.3	18.3	68.7
16	SE	107	3.6	3.3	-0.2	0.7	7.4
17	E	293	-3.3	2.0	0.3	2.5	1.5
18	NE	476	12.3	3.7	-0.7	-0.2	15.1
19	NNE	606	1.7	5.8	1.1	2.9	11.5
20	NE	907	1.9	2.4	-2.9	absent	1.4
21	SE	236	3.7	4.0	0.5	2.0	10.2
22	ESE	168	-4.5	-2.2	-3.2	-0.3	-10.2
23	NW	110	-2.4	0.2	-3.5	-1.0	-6.7
24	SSW	328	-0.3	1.2	-4.7	-3.3	-7.1
25	SSW	480	-1.3	2.1	2.0	2.6	5.4
26	SW	301	3.8	1.4	-1.0	2.7	6.9
27	WSW	141	-1.8	-2.4	-5.4	-2.2	-11.8
28	WNW	210	4.9	absent	1.9	3.3	10.1
29	NW	255	-1.1	2.3	1.8	3.8	6.8
30	NNW	328	-0.5	2.3	4.7	0.1	6.6
31	NNW	671	-0.4	4.6	2.5	2.3	9.0
32	NNW	724	-0.4	2.3	1.9	4.5	8.3
33	E	671	-3.2	0.1	-2.0	2.1	-3.0
34	ENE	587	-3.9	-0.8	-3.6	-0.6	-8.9
35	SSE	499	-0.9	0.8	0.5	1.1	1.5
36	SE	419	-0.7	absent	3.1	1.6	4.0
37	NE	690	-3.2	-2.8	-6.2	-3.3	-15.5
38	NW	556	-0.1	4.4	2.6	0.9	7.8
39	W	491	-1.0	3.1	1.8	1.9	5.8
40	N	514	-0.9	2.5	0.0	6.1	7.7
41	NNE	137	5.2	4.1	1.1	1.4	11.8
42	In Building	N/A	10.6	9.6	9.9	7.2	37.3
43	In Building	N/A	10.4	6.2	2.9	3.0	22.5
44	Distant Site	N/A	-2.4	1.2	-2.4	-1.6	-5.2
45	S	N/A	7.7	6.0	5.2	4.2	23.1

*All measurements have background subtracted. Negative values indicate dose rates not significantly different than background.

Table 4

Number of Facility Radiation and Contamination Surveys

1996	Radiation	Surface Contamination*	Air Samples	RWP
January	68	63	25	23
February	70	65	22	14
March	71	68	21	12
April	68	64	12	13
May	85	72	23	8
June	66	77	16	10
July	71	62	18	11
August	45	47	25	7
September	65	60	23	12
October	67	65	20	10
November	51	47	25	7
December	58	57	22	8
TOTALS	**785**	**747**	**252**	**135**

* Note: In addition, general building contamination surveys are conducted each normal work day.

Miscellaneous Items

In December 1996 Rex G. Ayers resigned from his Health Physicist position. The current Health Physics staff is as follows: Manager, Reactor Health Physics; Assistant Manager, Reactor Health Physics; four Health Physics Technicians; one part time Health Physics Technician Trainee; and one Senior Secretary.

MURR made two radioactive waste shipments in 1996. The total radioactive LSA waste shipped was 728 cubic feet.

SECTION X
SUMMARY OF RADIATION EXPOSURES TO FACILITY STAFF, EXPERIMENTERS AND VISITORS

1 January 1996 through 31 December 1996

1. Largest single exposure and average exposure are expressed in millirem.
2. Minimal exposure is defined to be gamma <10 mrem; beta < 40 mrem; neutron < 20 mrem.
3. ME = Number of monthly units reported with minimal exposure.
4. AME = Number of monthly units reported with exposure above minimal.
5. AE = Average mrem reported for all units above minimal.
6. HE = Highest mrem reported for a single unit for the month.
7. Dosimetry services except for "Self Reading Dosimeters" are provided by R. S. Landauer, Jr. & Co., Dosimeter Types: "C" - X, Gamma, Beta, Fast Neutron (Neutrak 144), Thermal Neutron; "G" - X, Gamma, Beta; "U" - TLD (1 Chip Ring).

PERMANENT ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	117	136	116	116	109	102	112	101	121	104	100	110
A M E	55	44	52	49	60	60	50	59	50	58	62	42
A E	78	61	63	83	69	69	62	52	61	50	49	59
H E	300	190	220	230	290	240	180	190	270	230	150	200

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	57	56	60	63	68	58	58	57	64	68	70	66
A M E	3	3	3	3	5	2	3	4	3	5	4	4
A E	10	20	27	67	48	50	23	30	25	53	38	10
H E	10	40	60	170	120	80	30	80	40	150	100	10

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	132	118	114	106	108	112	104	115	132	105	124	130
A M E	63	75	77	89	95	72	84	75	68	84	71	58
A E	200	171	158	190	149	161	167	135	197	144	143	159
H E	1000	1150	900	1610	670	680	870	720	1130	1040	930	820

Self Reading Dosimeters:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	17	21	11	14	4	2	15	5	12	15	5	17
A M E	75	73	82	75	86	86	76	84	80	73	83	70
A E	52	54	53	56	57	46	42	38	47	41	44	40
H E	213	179	189	225	300	253	169	179	206	165	186	158

SPARE ISSUE BADGES

"C" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	17	45	37	33	32	37	45	45	35	44	32	26
A M E	5	1	1	3	1	9	2	2	1	3	3	1
A E	12	10	10	37	50	24	70	70	20	20	20	10
H E	200	10	10	70	50	80	120	120	20	20	30	10

"G" Whole Body Badges (Deep Dose):

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	48	58	43	35	42	60	73	73	61	63	41	43
A M E	1	0	0	0	0	1	1	1	0	0	2	0
A E	10	0	0	0	0	50	50	50	0	0	10	0
H E	10	0	0	0	0	50	50	50	0	0	10	0

"U" TLD Finger Rings:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
M E	11	6	14	31	12	12	18	18	13	9	12	12
A M E	8	7	5	4	6	3	4	5	0	5	4	1
A E	260	40	108	215	83	93	40	66	0	46	130	40
H E	580	60	190	390	190	160	50	170	0	60	220	40

ALARA Program

The ALARA program continues to function as intended. Occupational exposure, releases to the sanitary sewer and releases from the facility ventilation system are reviewed monthly to ensure that they are not only within the regulations but are also reasonable for the work performed. The average monthly whole body deep dose to individuals in each ALARA review group are shown in the following table:

Group Name	Average Monthly Dose
Actinide Chemistry	minimal
Computer Development	minimal
Electronic and Mechanical Properties	minimal
Director's Office	minimal
Gamma Ray Scattering	minimal
Instrument Development	minimal
Magnetic and Crystal Structure	minimal
Thin Films and Interfaces	minimal
Analytical Group	minimal
Nuclear Archaeology and Geochemistry	minimal
Nuclear Engineering	minimal
Radiopharmaceutical	minimal
Facilities Operations	10 mrem
Neutron Optics	20 mrem
Services Applications	20 mrem
Health Physics	50 mrem
Reactor Operations	75 mrem