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RADIOISOTOPE DEVELOPMENT LABORATORY BUILDING 3047 HAZARDS REPORT

R. A. Robinson
E. E. Pierce

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ORNL-TM-946 (Rev. 2)

Contract No. W-7405-eng-26

ISOTOPES DEVELOPMENT CENTER

RADIOISOTOPE DEVELOPMENT LABORATORY BUILDING 3047 HAZARDS REPORT

Written by
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October 5, 1964

Second Revision
E. E. Pierce
May 24, 1974

Isotopes Division

JULY 1974

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
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UNION CARBIDE CORPORATION
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RADIOISOTOPE DEVELOPMENT LABORATORY BUILDING 3047 HAZARDS REPORT

R. A. Robinson and E. E. Pierce

INTRODUCTION

The Radioisotope Development Laboratory, Bldg. 3047, was originally designed and constructed for development work with low, intermediate, and high level beta- and gamma-emitting radioisotopes. A detailed description of the facility is included in this report.

Increasing requirements for alpha emitters such as ^{244}Cm have made it necessary to install special facilities in Bldg. 3047 for development work with these materials. The facilities are located in Rooms 110, 211, and 212 (see 3047 Building Plan — Fig. A-1, Appendix A).

Modifications have been made to the Bldg. 3047 hot cell area including the following: (1) HEPA filters in each of the four cells, (2) revised containment system utilizing a HEPA filtered roof exhaust system, and (3) emergency electrical power system for essential services.

FACILITY DESCRIPTION

Building Description

The Radioisotope Development Laboratory, Bldg. 3047, is a three-story, structural-steel-frame building having concrete block exterior walls. The overall dimensions are 142 × 40 × 31 ft. Building floor area and volume are distributed as shown in Table 1.

Table 1. Floor Area and Volume of Radioisotope Development Laboratory (Bldg. 3047)

	Volume (ft^3)	Net Usable Area (ft^2)	Service Area (ft^2)	Wall Area (ft^2)	Total Area (ft^2)
First floor[a]	92,320	4,811	810	734	6,355
Second floor	81,920	4,330	1,040	310	5,680
Third floor	30,000	1,037	2,118	217	3,372
Roof[b]	990	—	92	27	119
Total	205,230	10,178	4,060	1,288	15,526

[a]Includes vacuum pump pit.
[b]Includes stairwell (penthouse only).

The building is bounded on the west by Bldg. 3028, on the south by Isotopes Circle, and on the north by Hillside Avenue. On the east the building is joined to the Isotopes Technology Building, Bldg. 3047A, a three-story structural-steel-frame, concrete block building (see Fig. A-2, Appendix A) that has volume and floor area distributed as shown in Table 2.

Table 2. Floor Area and Volume of Isotopes Technology Building (Bldg. 3047A)

	Volume (ft^3)	Net Usable Area (ft^2)	Service Area (ft^2)	Wall Area (ft^2)	Total Area (ft^2)
First floor	33,800	1,031	1,552	237	2,820
Second floor	33,800	2,013	634	173	2,820
Third floor	33,800	2,222	424	174	2,820
Total	101,400	5,266	2,610	584	8,460

The Isotopes Technology Building is not a radiochemical facility; its air handling system is not connected in any way with the Radioisotope Development Laboratory ventilation system, and it is separated from the containment zone of the Radioisotope Development Laboratory by at least three doors in series. For these reasons, the Isotopes Technology Building is considered a separate building, even though there are connecting corridors between it and the Radioisotope Development Laboratory.

The Radioisotope Development Laboratory houses four manipulator-type hot cells, four laboratories, three alpha handling areas, a decontamination room, ten offices, a change room, and storage and service areas. The four hot cells and three of the laboratories are in the original containment zone of the building; the three alpha handling facilities (Rooms 110, 211, and 212) are in other containment zones; the offices, service areas, and one laboratory for low-level radioactive work are in noncontained parts of the building. Building location and floor plan drawings are shown in Figs. A-1 and A-2, Appendix A.

All rooms in Bldg. 3047 are equipped with a built-in sprinkler system for fire protection.

Building Alterations

The chemical engineering section located in the west end of Bldg. 3047 (Rooms 110 and 212) and the radioisotopic laboratory-west (Room 211) have been converted into three facilities for handling alpha emitters (Fig. A-1, Appendix A). Room 110 contains ~900 ft^2 of floor area. This does not include the air lock, Health Physics office, and stairwell. A lift truck access air lock permits entry to Room 110 through gasketed doors,

and access to Room 212 is accomplished through a gasketed hatch. A 3-ton overhead crane permits the transfer of equipment and material from the air lock to Rooms 211 and 212.

Each of the four shielded cells in Bldg. 3047 has been equipped with dual HEPA filters, and the cell operating area containment system has been revised to exhaust through an existing HEPA filtered exhaust system on the roof of the building.

An emergency electrical power system has been installed to provide standby electric power for essential services in Bldg. 3047 and Bldg. 3028.

Cell Description

The four manipulator cells designated A, B, C, and D are located as shown in Fig. A-1, Appendix A. A description of the cells is given in Table 3.

Table 3. Building 3047 Cell Description

Cell	Inside Dimensions (ft)	Cell Liner[a]	Equivalent Standard Concrete Shielding (ft)
A	8 × 6 × 13	3/16-in. 304 stainless steel	4.4
B	8 × 8 × 13	3/16-in. 304 stainless steel	4.4
C	8 × 8 × 13	3/16-in. 304 stainless steel	5.9
D	8 × 6 × 13	3/16-in. 304 stainless steel	4.4

[a]The cell roof plugs are concrete painted with four coats of Amercoat 33 HB.

The walls and tops of cells A, B, and D are fabricated of 3-ft-thick barytes concrete ($\rho \approx 3.5$). The top plugs and front and rear walls of cell C are fabricated of 2-1/4-ft-thick barytes concrete and 9-in.-thick steel plate. All common walls between cells are 3-ft-thick barytes concrete. The rear access doors on cells A, B, and D are of 16-in.-thick laminated steel plate; cell C has a 21-in.-thick laminated steel access door (see Fig. A-4, Appendix A).

Each cell has a laminated lead-glass viewing window composed of 6.2- and 3.3-density lead glass arranged to give shielding which is equivalent to the cell walls. The windows are of stepped construction (36 by 36 in. on operating face, 40 by 40 in. on inside cell face) and are sealed in the cell wall by 20-gage stainless steel flashing that is welded to the cell liner.

All steam, air, electrical, and water services originate from headers located above the operating corridor and enter the cell through a valve (or switch) on the operating face. The radioactive services, cell exhaust, hot drain, process drain, hot off-gas, and vacuum enter the cells from underground headers located behind the cell block.

Each cell has the following service penetrations:

- Two 10-in.-ID manipulator sleeves
- One 6-in. stepped sleeve and plug built into roof plug
- Four 1-1/2-in. stepped sleeves and plugs built into south wall of cell
- One 4-in. stepped sleeve and plug built between adjacent cells
- Six 1-in. offset sleeves capped inside and outside of cell
- Four 1/2-in. offset sleeves capped inside and outside of cell
- Five 1-in. electrical conduits
- One 1-1/4-in. electrical conduit
- One 6-in.-ID cell ventilation exhaust line with two 100-cfm HEPA filters
- Two 1-in. vacuum lines
- One 2-in. hot off-gas line
- One 2-in. radioactive hot drain
- One 2-in. process drain capped inside cell
- Four 1-in. process water lines
- One 1/2-in. hot process water line
- Two 1/2-in. 90-lb plant air lines
- Two 3/4-in. 15-psig steam lines
- Two 1/2-in. transfer lines from cask unloading station
- Seven 1/2-in. air lines for in-cell air hoist operation
- One 36- by 36-in. stepped shielding window penetration
- One 3-1/2- by 8-1/3-ft stepped cell door
- Roof plugs giving full cell opening (8 by 8 ft and 8 by 6 ft)
- Two 16-1/2 by 17-1/2-in. inter-cell conveyor openings
- One cell air inlet line (8-in. ID for cells A, B, and D and 12-in. ID for cell C)

Personnel entrance to the cells is normally through the cell doors on the south side of each cell. Equipment which is too large to go through the cell doors will enter through the roof plugs.

The introduction or removal of small items such as glassware and samples during cell operation is accomplished by using the inter-cell conveyor system which terminates in loading-unloading cubicles located on the east and west ends of the cell block. These cubicles have 6 in. of lead shielding and a 6.2-density lead-glass viewing window. The cubicle floor pans drain directly to the hot drain system, and the conveyor cart tunnel extending the length of the cell block drains to the individual cells. The conveyor cart can tolerate loads up to 50 lb having dimensions not exceeding 12 × 12 × 12 in.; it is driven by electric motors located outside each of the terminal cubicles. Cell ventilation on the cubicles is obtained by way of the cells; i.e., the cubicles have no independent ventilation system.

The stepped plugs which enter through the rear of the cells are provided only for bringing in instrument or special power bundles associated with a specific experiment. When they are not in use, these plugs are locked in place by a steel bar bolted to the wall. The 6-in. stepped plug entering the top of each cell can be used for surveying a cell during decontamination and to introduce a hose or spray rig during the initial phases of cell decontamination.

The cells are equipped with mercury vapor lamps for lighting during operation and incandescent lamps for lighting during maintenance.

The cell air handling equipment and containment instrumentation is described in the section on "Containment," subsection "Primary (Cell) Containment."

Description of Manipulator Cubicle (Room 110)

The inert atmosphere manipulator cubicle is located as shown in Fig. A-1, Appendix A.

The cubicle has a stainless steel liner with inside dimensions of 54 in. wide × 55 in. deep × 65 in. high. Enclosing the liner are six reinforced steel tanks with 18 in. of water shielding. A total radiation dose from 7.5 g of $^{244}Cm_2O_3$ inside the cubicle at a distance of 42 in. will be 0.3 mrem/hr.

An 18-in.-thick water-filled viewing window is incorporated in the operating (east) face of the cubicle, and the manipulators are Central Research Laboratories Model L (sealed) Master Slave units.

A glove box is attached to a vacuum access port on the south face of the cubicle and provides bag-in and bag-out capability for introducing and removing materials to and from the vacuum access port.

The cubicle is equipped for a controlled flow of argon and is operated at -0.5 in. water gage below the Room 110 pressure which is -0.3 in. water gage relative to the outside pressure. The cubicle exhaust is directed to the hot off-gas system through dual high-efficiency filters that are accessible for routine testing. One set of filters is located inside the cubicle, and each filter may be changed while the other is in operation. The second set of filters is located on the west wall of Room 110. The filters are replaced when the pressure drop exceeds 3 in. water gage.

The instrumentation is designed for fail-safe operation in the event of electrical or air failure, and a schematic outline is shown in Fig. A-5, Appendix A.

Pneumatically operated pressure control valves regulate the cubicle exhaust and the argon inlet flow. Sensing units on the exhaust system prevent excessive pressure or vacuum in the cubicle. All exhaust and inlet lines are protected by high-efficiency in-line filters.

The cubicle temperature is monitored by a heat-sensing unit that is connected to an audible alarm. The alarm activates the Bldg. 3047 panel alarm system in Room 109. Combustion inside the cubicle will be controlled by maintaining an inert gas atmosphere.

Personnel entrance to the cubicle is through an opening in the rear (west) side of the cubicle liner. The opening is equipped with a removable cover that contains glove ports and a viewing window. The water-shield tank for the rear of the cubicle is movable to permit access to the services, gloves, etc. All services to the cubicle are routed through service panels in the rear of the cubicle liner.

During major equipment changes in the cubicle through the rear access panel, a temporary plastic film enclosure will be erected to confine any radioactive contamination that may escape during the transfers. The enclosure will be connected to the cell ventilation system.

A vacuum access port permits the introduction and removal of materials to and from the cubicle without disturbing the inert-gas atmosphere.

The access glove box is equipped with a bag port and is designed to confine any radioactive contamination that may escape from the cubicle during the transfer of equipment or materials through the vacuum air lock. The glove box is connected to the cell ventilation system, and the inlet and exhaust are equipped with high-efficiency filters. The filters are accessible for routine testing.

The cubicle atmosphere is continuously monitored with a Beckman Model G-2 oxygen analyzer.

An evaluation is made of each new experiment by the Isotopes Safety Review Committee before the development work is started.

Description of Glove Boxes in Room 211

Three interconnected glove boxes and one access glove box are located in Room 211 as shown in Fig. A-1, Appendix A. The four boxes are constructed of stainless steel with safety glass viewing windows.

The access box and box C are equipped with bag ports for the introduction and removal of materials under sealed conditions.

All services, such as water, electricity, vacuum, etc. are introduced through sealed metal connectors in the rear of the boxes. Box A is connected to the hot drain system through a valved connection (See Fig. A-7, Appendix A).

Each box is equipped with a pressure-vacuum relief vessel to prevent overpressure of the box. The three process boxes are equipped with fire sensors and water detectors that are connected to a local alarm and to the Bldg. 3047 alarm system. The exterior of the glove boxes is protected from fire by the overhead sprinkler system in Room 211.

A description of each new experiment to be performed in the glove boxes is submitted to the Isotopes Safety Review Committee for examination relative to mechanical, chemical, and radiation safety before the development work is started.

A detailed operating procedure and equipment checklist are included in Appendix C.

Process Equipment

Building 3047 is a research and development laboratory, and most of the radioactive processing equipment is set up for each experimental investigation and dismantled at the conclusion of the experiment. Four high-temperature vacuum furnaces are installed in "contained" areas of the building (Rooms 113 and 212) and are used for long-term compatibility experiments with radioactive compounds and encapsulating materials. All radioactive materials to be tested in the furnaces are encapsulated to reduce the probability of contamination.

The access port to each furnace is equipped with a glove box enclosure with bag-in, bag-out, and inert gas capabilities. Each enclosure is equipped with a heat sensor and a pressure relief vessel. When it is necessary to remove the access port in order to make repairs to the furnace components, a plastic enclosure is erected around the furnace to denote a contamination zone. The enclosure prevents the spread of radioactive contamination to the surrounding area. A copy of the operating procedure for the glove boxes is included in Appendix C.

Auxiliary Equipment

Vacuum System

House vacuum for both the cells and laboratories is provided by a single-stage, rotary, water-sealed pump (Nash Hytor Model H-4). The pump and all piping and valves in the system are 300 series stainless steel (304L and 347). The seal water is recirculated through a heat exchanger which can discharge the water to hot drain if it becomes contaminated. The cooling water passing through the heat exchanger to cool the seal water is discharged to the process drain at the rate of 8 gal/min. The air flowing in the system passes through a 100-gal stainless steel surge tank before going into the pump to disengage any liquid or solid that may be pulled into the vacuum system. The exhaust air from the pump is discharged into the cell ventilation duct under the building.

The system also includes an air eductor in parallel with the mechanical vacuum pump to provide high pumping capacity during the last stages of pumpdown from 7-in. Hg abs to 3-in. Hg abs. This eductor uses air from the vacuum pump room for the motive fluid and discharges into the cell ventilation system. The entire system including the vacuum pump, air eductor, seal water circulating pump, seal water hold tank, seal water heat exchanger, and the vacuum surge tank is located in an underground pit below first floor equipment Room 102. Access is through a manhole on the south side of the building. The roof and wall facing the access way provide 12 in. of concrete shielding.

Refrigeration

A Trane "Centravac" compressor and chiller unit (Freon-22) with a capacity of 175 tons provides chilled water which is circulated at 100 gal/min to the air-handling units in the building. The unit is located in the first floor equipment area, Room 102. Heat removal from the compressor is accomplished by a closed-loop water system operating through a dual cooling tower located on the roof. The water-circulating pumps for both the tower water and chilled water are located in the second floor equipment area, Room 206. Both the tower-water and chilled-water circulating systems have an installed spare pump.

Hot Water Systems

The equipment for both domestic and process hot water systems is located in Room 206 and consists of a steam-to-water shell and tube heat exchanger, hot water hold tank, and an expansion tank. A centrifugal pump is used to circulate the process hot water through the reheat coils of the air-handling system. Steam taken from the 90-psig header and reduced to 15 psig is used in the heat exchangers. Both systems are equipped with high-temperature and high-pressure relief valves.

All auxiliary equipment in Bldg. 3047 is included in the Plant and Equipment Division (P&E) routine maintenance program and is inspected and serviced regularly.

Air-Handling Equipment

The description and operation of this equipment are given in the section on "Containment."

Jet Eductors

Table 4 describes the jets having service functions in Bldg. 3047. All jets except the vacuum booster are manually operated.

Table 4. Building 3047 Jet Eductors

Size and Material	Motive Fluid	Location	Discharge Point	Function
2-in. IPS, 347 stainless steel	Air, atm pressure	Vacuum pump pit	Cell ventilation duct	Booster for vacuum system
3/4-in. IPS, 347 stainless steel	Steam, 60 psig	Vacuum pump pit	Hot drain	Emptying vacuum surge tank, seal water tank, and sump

Table 4. continued

Size and Material	Motive Fluid	Location	Discharge Point	Function
3/4-in. IPS, 347 stainless steel	Steam, 60 psig	Cell D	Hot drain	Emptying cell ventilation duct sump
3/4-in. IPS, 347 stainless steel	Steam 60 psig	Cell D	Hot drain	Emptying hot off-gas header sump

EMERGENCY ELECTRICAL POWER SYSTEM

A 45-kW emergency generator assembly has been installed on the north side of Bldg. 3047 to provide emergency electrical power for Bldg. 3047 and Bldg. 3028. The electrical distribution panels and transfer switch are located on the north wall of Room 110 in Bldg. 3047. Electrical service panels are located as follows:

Panel No. EP-1	Bldg. 3047	Room 201
Panel No. EP-1A	Bldg. 3028	East Airlock
Panel No. EP-2	Bldg. 3047	Room 102
Panel No. EP-4	Bldg. 3047	Room 110
Panel No. EP-5	Bldg. 3047	Room 212

Emergency power is distributed in Bldg. 3047 to provide emergency electrical power to the following equipment: cell emergency lights; radiation detection and survey instruments, including CAM, CAAM, monitrons, neutron monitors, etc.; Bldg. 3047 and Isotopes area public address systems; Bldg. 3047 fire alarm; alternate exhaust fan AJ-102B; and spare circuits for future experimental equipment. The location of the distribution system is shown on Drawings E-20399-ED-005-D and E-20399-ED-007-D-1.

The emergency power system is tested weekly with a dummy load and monthly by simulating a power failure.

CONTAINMENT

The containment zones of the Radioisotope Development Laboratory are shown in Fig. A-1, Appendix A. The cells, cubicles, and glove boxes are considered the primary containment, and the portions of the building housing the facilities are considered the secondary containment. The east end of the building is uncontained.

Primary Containment -- Cells

The primary volume to be contained is the cell block. Containment of this volume is obtained by means of the structural strength resulting from the concrete and steel construction of the cells and by controls to maintain the cells at a pressure that is always less than the surrounding building.

The physical description of the cells, including service penetrations, is given in the section, "Facility Description," subsection "Cell Description." The cells, including windows, doors, and plugs, will withstand static pressures in excess of 600 lb/ft^2 without movement. An accident that would cause a massive failure of the cell walls is not considered "credible" because of the procedural safeguards described under "Chemical Processing" regarding the type and quantities of reagents used during cell operation.

The cell doors are constructed of laminated steel plate, lined with 11-gage stainless steel, and stepped to prevent radiation shine. The doors on cells A, B, and D are 16 in. thick, and the door on cell C is 21 in. thick. The doors are suspended on crane-type hinges and, when closed, they seat against a cell neoprene gasket. The first (cell side) step in the door threshold is sloped toward the cell and is equipped with a drain to carry off any decontaminating solutions that may be sprayed against the door. The cell floor is 6 in. below the door threshold to prevent the loss of any liquid which might accumulate on the floor. Each cell floor has a nonvalved floor drain to hot drain connection.

Each cell has a three-piece roof plug. In addition, cell C has two separate pieces of armor plate under the concrete plugs to provide the additional shielding designed for this cell. The plugs are arranged so that it is necessary to remove a relatively narrow key plug on each cell before any of the other plugs can be removed. When this key plug is lifted, a circuit is de-energized which closes the inlet air damper to provide increased air flow across the opening.

Under normal operating conditions, air enters each cell through a 90% efficiency filter, an automatic flow control valve, and a back-flow preventer. The air leaves the cell by way of two in-cell 100-cfm HEPA filters and goes through an underground duct to the Isotopes Area Filter Pit, where it passes through a bank of FG-25 roughing filters and a bank of HEPA filters before going to the 3039 stack.

The leakage of air into the cells by paths other than the normal air inlets is minimized by sealing all wall penetrations. The cell doors, when closed, compress a 1/2-in.-thick neoprene gasket to 7/16 in. to prevent air flow through door cracks; the cell roof plug cracks are sealed with oakum and tar; all spare service sleeves are capped both inside and outside the cell; spare service plugs are sealed with putty; the cell window liners are sealed by 20-gage stainless steel flashing

welded to the cell liner; the slave arms of the manipulators are fully booted; and the manipulator operating tapes pass through a felt wiper seal in the through tube.

Before a cell door or roof plug is opened, the cell is decontaminated to a safe level as determined by smear results and radiation surveys; and one of the 100-cfm HEPA filters is removed from its sealed position to allow a greater flow of air into the cell. When the door or roof plug to a cell is opened, a switch automatically closes a damper in the inlet air duct to the cell which directs all air flow through the door or roof opening. Each exhaust duct is equipped with a damper that may be controlled from outside the cell. The connecting rod is sealed both on the inside and outside of the cell wall by a lead-filled rotary seal. Each damper is normally set in the full-open position and the cell pressure and air flow controlled with the inlet air damper.

During normal operation, the cells are maintained at -1 to -2 in. water gage pressure with respect to the building pressure. Each cell has a diaphragm-type (Magnehelic) pressure-differential indicating instrument to show the difference between cell and operating corridor pressures. Each cell also has Magnehelic gages on the operating face to indicate the pressure drop across the in-cell filters and on the access side of each cell to indicate the pressure drop across cell air inlet filters. All of the cell air-flow controls are of fail-safe design. The loss of electric power and/or compressed air for damper operation will result in the dampers being opened to their fullest extent to provide maximum cell ventilation flow. The in-cell filters are tested on a routine dioctylphthalate (DOP) test schedule.

Building Containment

The portions of the building designed to meet maximum containment standards include the cell block, cell operating and access areas, three hot laboratories on the second floor, and the decontamination room (Room 105) in the central part of Bldg. 3047. Rooms 110, 211, and 212 in the west part of the building operate continuously under contained conditions (-0.3 in. water gage). The portion of the building designed to meet these maximum containment criteria is outlined in Fig. A-1, Appendix A.

The air supply system for the building is comprised of three independent units designated as System 1, System 2, and System 3.

System 1

Revised to a recirculating system with high-efficiency filtration. Supplies air for the west end of the building including Rooms 110 and 212, laboratory Room 211, and office Rooms 213 and 111. Rooms 110, 211, and 212 are included in the maximum containment areas of the building. The return air from Rooms 110 and 212 is filtered locally through high-efficiency filters, travels through a bank of roughing filters and a bank of 90% efficiency filters in the Room 315 plenum, and is discharged into a duct-distributor system serving the areas mentioned above. The

fan and filter housing for this system is located in plenum 1, Room 315. Automatic dampers are set to prevent the negative pressure in Rooms 110, 211, and 212 from exceeding -0.5 in. water gage.

Revisions to the system include conversion from 100% makeup to a recirculating system with minimum makeup to maintain a safe and comfortable environment for the operating personnel. The recirculating air is filtered in Rooms 110 and 212 through FG-50 roughing filters and high-efficiency filters.

Rooms 110, 211, and 212 exhaust continuously to the cell ventilation system through FG-50 filters in each room and high-efficiency filters at the Isotopes Area Filter Pit. Each room is maintained at -0.3 in. water gage.

The three rooms are protected from fire by overhead sprinklers and a fire alarm pull box, and Rooms 110 and 212 have hose cabinets. Each room has one door with access to a stairwell and one door accessible to an emergency exit. A vehicle air lock permits vehicle entry to Room 110 through gasketed doors and to Room 212 through a gasketed hatch.

Each room is equipped with a constant alpha air monitor (CAAM) that is connected to the monitored alarm panel in Room 109. Alpha personnel monitors are positioned at each personnel access door, and neutron detectors with built-in alarms are located in each room. A manual switch for emergency use is located in each room and connected to the alarm panel in Room 109.

All operating personnel assigned to Rooms 110, 211, and 212 have had training with the fire-control equipment and are experienced in the detection and handling of radioactive materials.

System 2

Supplies air to the central (contained) portion of the building. The air is drawn through a stack on the roof of the building and through a bank of roughing filters and a bank of 90% efficiency filters. Air is discharged from the System 2 volume by way of the hoods in Rooms 105, 109, 208, 209, and 210, by way of the four cells, and by an exhaust fan on the roof. The roof fan exhausts through a bank of roughing filters and a bank of CWS-type absolute filters. The filters are routinely DOP tested. When the central portion of the building goes into containment, the roof exhaust fan continues to operate, the System 2 supply fan shuts down, and an automatic damper closes the duct going to the outside. The contained area pressure changes from 0.1 in. water gage to >-0.3 in. water gage in <20 seconds.

The central portion of Bldg. 3047 is equipped with two exhaust fans and damper assemblies. These are AJ-102A (primary) and AJ-102B (secondary or emergency). AJ-102A runs under normal conditions, and the control panel is located in the SE corner of Room 113. A photohelic gage measures the fan discharge air flow. A pneumatic damper control permits

control of the air flow through the fan. If the primary fan (AJ-102A) malfunctions allowing the stack pressure to drop below the photohelic gage low-set point (0.1 gage 1320 cfm) the secondary fan (AJ-102B) is energized and supplies auxiliary exhaust capacity. AJ-102B is also connected to the emergency power system and will operate during periods of electrical power failure.

The central portion of Bldg. 3047 can be put into "contained" condition by three methods:

1. Manually by means of a push button located in the southeast entrance-way.

2. Automatically by pressure switches located on each cell. These switches are set so that the building goes into containment if any cell comes within 0.25 in. water gage of the operating corridor pressure. When a cell door or plug is open, the pressure switch for that cell is automatically disconnected from the building containment circuit.

3. Automatically by CAM-type radiation monitoring instruments. There are eight of these instruments tied into the containment circuit, and a radiation signal from at least two instruments simultaneously is needed to put the building in containment. The location of the instruments is shown in Fig. A-6, Appendix A.

When the central portion of the building goes into containment, the following things happen essentially simultaneously:

1. An audible and visual alarm is given at a containment panel in the operating corridor, red warning lights flash at all entrances to the containment area, and audible alarms sound throughout the containment area.

2. The exhaust system serving the central portion of Bldg. 3047 continues to operate. Exhaust which is going by way of the cell ventilation system (hood exhaust and cell exhaust) continues. The exhaust fan serving the east end of the Radioisotope Development Laboratory (office area) stops to assure an air flow pattern toward the central portion of the building.

3. The air supply fan serving System 2 ceases operating, and an air-operated damper seals it off from the outside. The air supply fan serving System 3 continues operating to ensure that these noncontained areas stay at a higher pressure than the contained (System 2) area. See Appendix B for the containment system test procedure.

All the damper actuators associated with the containment operations are air actuated and move to the containment condition in the event of an air or electrical failure.

There are no doors which connect directly from the contained area of the building to the outside. Both personnel and vehicles must pass through two doors to enter the contained portion of the building. The vehicle doors are interlocked to permit only one door to be open at a time; the personnel entrances are not interlocked. A remote radiation indicator station is located in the southeast entranceway to indicate the radiation level at each of the CAM's in the contained area. Another indicator station is located in the operating corridor.

System 3

Supplies air to the office areas, laboratory Room 207, east end storage, and change and equipment areas. These areas are not within the maximum containment zone of the building. The supply fan is located in plenum 3, Room 313. Air is drawn in through a stack on the roof, through a bank of roughing and 90% efficiency filters, and into a duct system serving the System 3 area. Air is discharged from this area by way of the hoods in Room 207 and by an unfiltered exhaust fan on the building roof. When the central portion of the building goes into containment, the roof exhaust fan shuts down creating a positive pressure which assures that the air flow pattern will be toward the contained area.

The adjoining Isotopes Technology Building, Bldg. 3047A, has its own air supply and exhaust systems, which are entirely independent of those in the Radioisotope Development Laboratory.

CHEMICAL PROCESSING

Since Bldg. 3047 is a research and development facility, there is no standardized routine chemical processing. A wide variety of processes and operations is carried out on an experimental basis, such as solvent extraction, ion exchange, precipitation, and distillation. In addition, mechanical testing of sources is performed in both cells and laboratories.

Feed for the experimental processes may be in the form of purified radioisotopes from other Isotopes Development Center operations, reactor targets, gross fission product waste solutions from fuel processing operations, and fission product fractions separated at other AEC facilities. In addition, it is expected that numerous experiments using nonradioactive solutions or tracer quantities of activity will be performed in the laboratories and engineering area.

A list of all the reagents to be used is not feasible because of the experimental nature of the work. All proposed experiments are submitted to the Isotopes Safety Review Committee for review with particular emphasis on possible side reactions that could be hazardous. The use of flammable solvents in the cells is restricted to quantities not in excess of 1 liter, and the routine use of equipment using natural gas, such as furnaces and burners, is not permitted in the cells. Compounds which can decompose explosively, such as alkali chlorates and ammonium nitrate, are not used in the cells in quantities exceeding 1/4 lb, unless they are in solutions known to be safe and to have no chance of being concentrated to dryness.

The chemical processing equipment used in the cells will vary from ordinary laboratory glassware up to multigallon stainless steel process vessels. The total volume of all the process vessels in a cell will not exceed 200 gal in cells B and C and 150 gal in cells A and D. These volumes are less than those that could be held in the cell floor pans (256 gal and 192 gal) without the level of the liquid reaching the door thresholds. Experiments for manipulator cubicle and glove box operation in Rooms 105, 110, 211, and 212 are outlined in writing and submitted to the Isotopes Safety Review Committee for evaluation prior to the installation of the equipment assemblies.

CRITICALITY

There will be no fissionable materials present in quantities that are subject to a nuclear chain reaction. No more than 500 g of ^{235}U and 10 g of ^{239}Pu will be in the building at one time. Some materials such as ^{242}Cm which undergo spontaneous fission decay will be used, but they will not be subject to a nuclear excursion-type incident.

OPERATING SAFEGUARDS

Procedures

Procedures for various service operations have been established and are contained in Appendix C. These procedures are designed only to instruct the individual carrying out the operation. They are not in the form of run sheets nor are they necessarily used as checklists. Deviation from the procedures is not permitted without supervisory approval. New or modified procedures are reviewed by the building supervisor before being put into effect.

Run Sheets

Formal process run sheets are not normally used in the operation of the building due to the experimental nature of the work as contrasted with routine production operations. Each experiment involving radioactive materials, whether in the cells or laboratories, is under the direction of a qualified scientist; and, as noted previously, the experiment is planned and reviewed with particular emphasis on hazards. The scientist may have one or more technicians operating his apparatus, and he will provide them with written or verbal instructions depending on the complexity and hazard of the operation. The technician is not permitted to deviate from these specific instructions unless he obtains permission from the scientist in charge of the experiment. In the case of high-level experiments in the cells, the scientist in charge is not permitted to deviate from the planned and approved experiment with respect to chemicals used, temperatures, pressures, or other critical conditions without first consulting his supervisor.

Built-in Safeguards

Several built-in safeguards have been designed into the building to provide protection in the event of operating error or equipment failure.

Containment System

As mentioned in the section on "Containment," the containment system, in addition to manual actuation, will be actuated automatically by any two of eight radiation detection instruments or by pressure switches sensing an inadequate pressure differential between the cells and operating areas. Also, the system will fail in the safe (contained) condition if any utilities operating the system (electricity, air) should be shut down.

Cell Radiation Monitors

A beta-gamma monitron is located behind each cell in line with the cell door so that it "sees" into each cell as the door is opened and will give an audible alarm if there is an exposed source in the cell. Neutron monitors are installed in Rooms 110, 211, and 212 to continuously monitor the areas for excessive neutron radiation.

Constant Air Monitors

Alpha monitors and beta-gamma monitors are installed in all areas where radioactive materials are handled. Selected instruments are connected to the alarm systems of the contained areas.

Neutron Monitors

Neutron monitors with adjustable set-point for an alarm are installed in Rooms 110, 211, and 212.

Vacuum System

The entire vacuum system is constructed of stainless steel, and all vacuum lines coming out of the cells are shielded with a minimum of 12 in. of concrete to provide shielding in case radioactive materials are accidentally pulled into the system. The pump is protected by a 100-gal disengaging tank to provide a volume for dropping out any radioactive materials that might get into the system. The pump, surge tank, and accessory equipment are located in an underground pit with a minimum of 12 in. of concrete shielding. A beta-gamma monitron in the pit provides a reading at the operating panel in the equipment room to indicate if radioactive material has been pulled into the pump system.

Laboratory Hot Drains

All hot drain lines coming from the laboratory areas are shielded where necessary to the point where they go underground. The annular lead shields are equipped with drains to permit the draining of any liquid that would collect if one of the hot drain lines developed a leak.

Air Handling

The building air supply is broken into three separate systems to minimize the possibility of contaminating the whole building from an incident in one section of the building. The air intakes are equipped with 90% efficiency filters to provide protection against contamination resulting from an incident outside the building.

Cell Floor Drains

The cell floor drains are not valved and have raised screens to ensure that they will be open when a cell is being washed down. They are equipped with removable water-sealed traps to prevent the backflow of contaminated air.

Back-flow Preventers

Back-flow preventers are provided on all cell air inlets and on all cell ventilation headers tying into the main building cell ventilation duct. All above-ground building cell ventilation lines are of stainless steel, all-welded construction; the underground headers are of concrete.

Hot Hoods

The walls behind the hot hoods in the three hot laboratories have 4-in.-thick lead panels to ensure that a source placed in a hood in one laboratory will not irradiate an individual in the next room.

Inter-cell Plugs

The 4-in. stepped plugs in the walls between cells are located 6-1/2 ft above floor level to ensure that an individual entering one cell will not be in line of sight of a source in an adjoining cell even if he forgot that the inter-cell plugs were open. The inter-cell walls provide a full 3 ft of barytes concrete shielding.

Alarms

The following visual and/or audio alarms are provided in the building:

1. Containment system actuated
2. Low cell pressure differential
3. High level, hot off-gas sump
4. High level, cell ventilation sump
5. Inter-cell conveyor in or entering an open cell
6. Laboratory evacuation alarm
7. Fire alarm
8. Radiation monitor alarms
9. Vacuum system mal-operation alarm
10. Air supply ductstat temperature alarm
11. Low building voltage alarm
12. High-temperature sensing unit alarm
13. Glove box water level alarm

Procedural Safeguards

In addition to the procedures previously mentioned, the following regulations are in force in the building:

1. Electrical maintenance is done only when the appropriate circuit breaker is tagged out.

2. Entrance to a cell is not permitted until a Health Physics survey has been made.

3. All maintenance and set-up work in a cell requires a standard Radiation Work Permit and an observer.

4. Lead burning and welding work require a standard Burning Permit.

5. Technicians and operators are not permitted to experiment on their own.

6. Laboratory regulations regarding the tagging of equipment, carriers, and samples are strictly followed.

7. Modification of building services and service equipment is not permitted except as specifically authorized by the Department Supervisor. Procedural changes may only be authorized at the Department Supervisor level or higher.

Building Services and Equipment Maintenance

The service equipment in Bldg. 3047 is on the Routine Maintenance System administered by the P&E Division. This includes a routine inspection of machinery components on a schedule based on P&E Division experience with similar equipment, lubrication of moving parts, tightening or replacing valve packings, etc. In addition, all equipment associated with the containment system is tested at least once a week. Pressure drop gages are connected across all filters in the building to provide an indication of when the filter should be changed. Filters are replaced by the P&E Division on request; all nonscheduled maintenance is done by request to P&E.

PERSONNEL EXPOSURE

Maximum Curie Load

It is expected that virtually all radioisotopes below uranium, as well as a few transuranium elements, will be handled in varying amounts in Bldg. 3047. The isotopes representing the greatest amounts of activity, as well as hazard, in the building are given in Table 5.

Table 5. Hazards Summary — Building 3047

Isotope	Maximum Inventory (Ci)			Maximum Credible Accident Results		
	In Plant	In Cell	In Dispersible Form[a]	Stack Discharge[b] (Ci)	Downwind Dose[c] (millirem)	Maximum Contaminated Area[d] ($mile^2$)
Strontium-90	1×10^6	2.5×10^5	2.5×10^3	0.6	1.2×10^2	3.4
Cerium-144	1×10^6	1×10^6	5.0×10^4	11.7	3.14×10^1	18
Promethium-147	1×10^5	5×10^4	5×10^3	1.2	0.3	1.8
Cesium-137	5×10^5	1.25×10^5	1.25×10^4	2.9	4.6	4.5
Mixed fission products[e]	2.5×10^4	2.5×10^4	2.5×10^4	5.8	1.4×10^1	9.0
Cobalt-60	6×10^4	6×10^4	1×10^3	0.2	0.4	0.4
Curium-242	4×10^4	4×10^4	4×10^3	0.9	1.4×10^2	45
Curium-244	3.2×10^4	3.2×10^4	3.2×10^3	0.7	1.8×10^3	35
Americium-241	3.21×10^2	3.21×10^2	3.21×10^2	0.07	1.1×10^2	3.5
Uranium-235	1×10^{-3}	1×10^{-3}	1×10^{-3}	2×10^{-7}	3×10^{-6}	1×10^{-5}
Plutonium-239	6.13×10^{-1}	6.13×10^{-1}	6.13×10^{-1}	1.2×10^{-4}	0.96	6×10^{-3}

[a] In solution or a nonencapsulated dispersible solid.
[b] Based on 20% of dispersible inventory reaching the Isotopes Area Filter Pit.
[c] Total integrated (lifetime) dose assuming proper filter operations; ORNL-TM-16.
[d] Contaminated to greater than 30 dis/min·dm^2 alpha or 1000 dis/min·dm^2 beta, gamma assuming proper filter operation.
[e] Six months' decay containing 760 Ci ^{90}Sr ($MPC_{a40} = 6.6 \times 10^{-9}$ $\mu Ci/cm^3$.

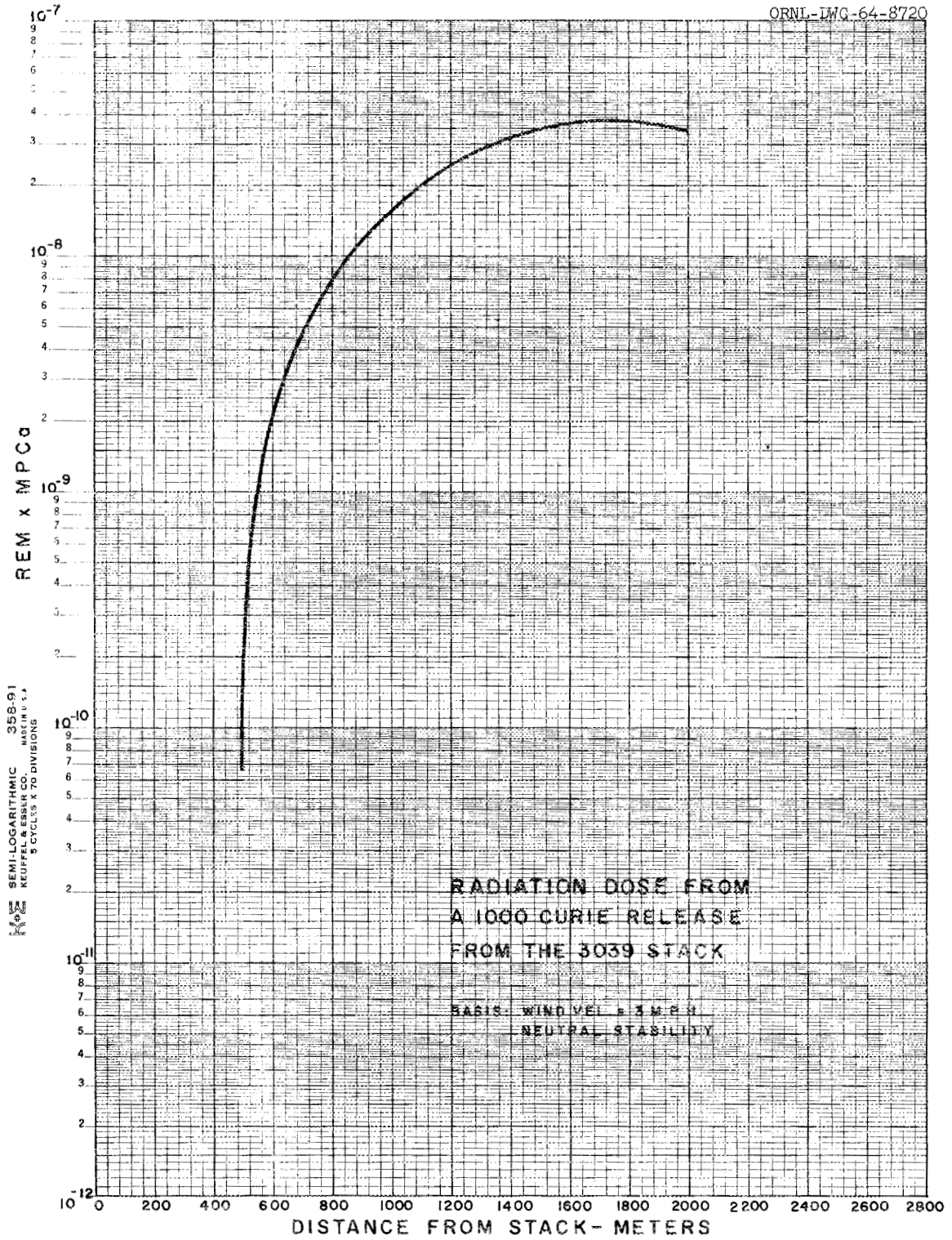


Fig. 1. Radiation Dose from a 1000-Ci Release from the 3039 Stack.

The distribution of the downwind dose normalized to a 1000-Ci stack release and stable atmospheric conditions is plotted in Fig. 1. The calculation method used for Table 5 and Fig. 1 is given in Appendix D. The values in Table 5 are based on the assumption that the Isotopes Area Filter Pit is 99.95% efficient in removing particles sized 0.3 μm and larger as shown by the DOP test. The values can be adjusted for other filter efficiencies by multiplying by the factor:

$$\frac{(0.988)(1 - \text{filter DOP efficiency}) + 6.8 \times 10^{-4}}{11.74 \times 10^{-4}}$$

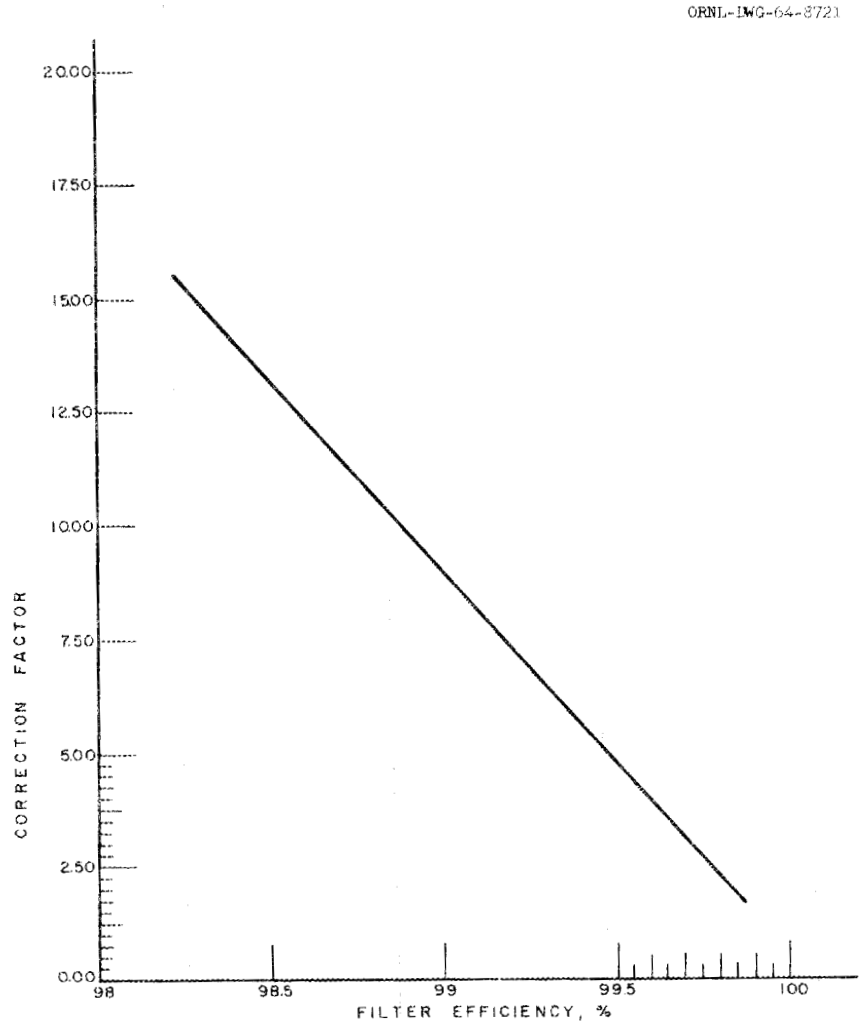


Fig. 2. Filter Efficiency Correction Factors.

A plot of these correction factors to be used with Table 5 is given in Fig. 2. The downwind dose and contaminated area values given in Table 5 represent the maximum credible accident for the facility because they are based on the assumption that the entire dispersible inventory of a cell becomes airborne and 20% of this activity reaches the Isotopes Area Filter Pit. The leakage of activity from the cell and building will be

insignificant compared to the stack release. An accident which breeches the cell block is not considered credible because of the previously mentioned limitations (page 13) on the quantities of potentially explosive materials allowed in the cells.

The maximum dose to personnel in the building due to overpressurization of the cells will depend largely on the length of time the cell is pressurized and the pressure level. Assuming an accident that releases about 2.7 ft^3 of gas to the containment zone of the building, the doses received by personnel in 2 min while evacuating the building were calculated (Appendix D), assuming that this gas carried 10 mg/m^3 of radioactive dust (equivalent to a very dense fog) which mixes uniformly with the air in the containment zone, and are shown in Table 6 for the radioisotopes of significance.

Table 6. Maximum Credible Accident Dose to Building Personnel

Isotope	Personnel Dose in 2 min (millirem)
Strontium-90 as titanate	91.5
Curium-242 as oxide	12,050
Curium-244 as oxide	53.5
Americium-241 as oxide	121
All other radioisotopes to be handled	<50

Building Personnel

The planned staff normally having offices or work areas in Bldg. 3047 consists of nine scientists and seven technicians. Normally, all of these people will be working straight days, but on occasion there may be shift work in connection with a particular experiment or program. It is possible, but not probable, that all these people can be in the contained portion of the building at the same time. The building has an additional office for one Health Physicist who will carry out the health physics functions for Bldgs. 3047, 3028, and 3029. Normally, it is expected that there will also be present two or three P&E Division employees doing maintenance work or setting up equipment as well as one or two visitors not assigned to the building.

RADIATION AND CONTAMINATION CONTROL

The fixed radiation instruments in Bldg. 3047 are listed in Table 7. The locations of the instruments in the building are indicated in Fig. A-6, Appendix A.

Table 7. Building 3047 Radiation Instruments

Type	Quantity	Testing Frequency	Type of Activity Detected	Containment Alarm Setting
β,γ CAM (Q-2240)	8	Daily - HP	β,γ particulate	1800 counts/min
γ monitrons (Q-1154)	5	Daily - HP	γ	None
β,γ personnel monitors (Q-2091)	10	Daily - HP	β,γ	None
α CAM (Q-2340)	5	Daily - HP	α particulate	600 counts/min
Neutron monitors	3	Daily - HP	fast neutron	None
α personnel monitors (Q-2270)	6	Daily - HP	α	None

In addition to the fixed instruments, there are ten portable soft-shell Cutie Pie Survey Meters and nine portable G-M Survey Meters with ~1-mg/cm^2 end-window probes for detecting weak emitters such as ^{99}Tc and ^{147}Pm. A Survey Meter with an appropriate probe is located at each routine personnel exit in the containment zones, and there is a sign on the door to instruct all personnel to monitor their shoes before leaving the area. Nine portable (Q-2091) personnel alpha monitors are located in the building. Three fast-neutron monitors are used in Rooms 110, 211, and 212 as required. Four portable fast-neutron monitors and two portable thermal-neutron monitors are available in the Health Physics office. The containment areas are spot smeared daily by Health Physics, and selected portions of the building are given smear checks each week. Cell areas are roped off and covered with blotting paper before entry as described in the Cell Entry Procedures in Appendix C.

LIQUID WASTES

Low-Level Radioactive Waste

The building connections to the low-level waste system (process waste system) are:

1. All laboratory sink, bench, and hood drains

2. Cooling water (not seal water) for vacuum pump

3. All building floor drains

4. Process drain connection in each cell — normally capped unless directly connected to a particular piece of experimental equipment for the discharge of cooling water or steam condensate

5. Fan plenum chamber drains

6. All steam condensate traps

7. High-pressure steam condensate flash tank

8. Chilled-water system drain including cooling tower

The process drain system in the building is constructed of Duriron pipe except for those portions in the cells which are stainless steel. The process waste leaving the building ties into the existing Isotopes Area process drain system which flows directly to the settling basin with no intermediate hold-up tanks in the line. There are no cross connections between the process waste system and the hot waste system. The process waste stream from the building is not separately monitored or measured. Under full operating conditions, the total process waste flow should not exceed 5,000 gal/day.

Hot Waste

The building connections to the hot drain system are:

1. Floor drains in each cell

2. One hood drain from each laboratory

3. Hot off-gas sump jet discharge (via collection tank and cell D floor drain)

4. Cell ventilation sump jet discharge (via collection tank and cell D floor drain)

5. Vacuum pump surge tank, jet discharge

6. Vacuum pump seal water tank, jet discharge

7. Vacuum pump sump, jet discharge

8. Capped-off connection in Room 110

9. Capped-off connection in Room 105

10. Carrier transfer line trench drain

11. Conveyor cubicles floor drains

12. Cubicle in Room 110

13. Personnel decontamination shower drain

14. Glove box drain — Room 211

15. Valved connection in Room 105

All hot drain lines in the building are shielded where necessary and are constructed of Type 304L schedule 80 stainless steel pipe. All joints are welded and have been radiographed, and the system has been pressure tested at 100 psig.

The hot drain header leaves at the west end of the building and ties into the existing Isotopes Area Hot Drain System which discharges into the WC-10 tank. This tank is sealed and approved for all types of radioactive liquid waste. The hot waste leaving Bldg. 3047 is not separately measured or monitored. During normal operation, the volume of hot waste from Bldg. 3047 should not exceed 400 gal/day. During periods of cell decontamination, however, 2000-3000 gal/day may be discharged through the hot drain system.

The bulk of the hot waste will consist of aqueous solutions of various salts and nitric acid that are not unduly corrosive to stainless steel. Normally, the waste will contain only beta and gamma activities and will not exceed 10 Ci/liter. Small amounts of alpha activity ($\sim 10^5$ alpha counts/min·ml) may occasionally be discharged into the hot drain system.

Storm Sewer

The only connections from Bldg. 3047 to the storm sewer system are the building roof drains, the cooling tower pan overflow and dump line, and the vacuum furnace cooling systems in Rooms 110, 113, and 212. Neither the lines nor the pieces of equipment are connected with any radioactive process or drain facilities.

GASEOUS WASTE

Hot Off-Gas System

Hot off-gas service enters the west end of the building underground through a 4-in. stainless steel header which is connected to the existing Isotopes Area 6-in. off-gas main. One 2-in. line to each of the four cells and one 3-in. line to the chemical engineering area are the only hot off-gas service outlets in the building. The pressure on the building header normally runs about -30 in. water gage. There is no automatic pressure control on the building header, but local pressure regulators may be installed in connection with a specific experimental setup where constant off-gas pressure is required.

There are no scrubbers or filters installed as permanent equipment in the building hot off-gas system. Temporary scrubbers and filters are installed as part of an experimental setup when there is a possibility of corrosive vapors or a significant quantity of radioactive particulate getting into the off-gas header. The hot off-gas is scrubbed and filtered at the 3039 stack area facility prior to being discharged.

The hot off-gas header in Bldg. 3047 is below the elevation of the Isotopes Area hot off-gas and hot drain headers. Any liquid which gets into the building header flows by gravity to a sump located in the line under cell D. The sump will hold about 4 gal before the liquid starts backing up into the header. The sump is equipped with an air purge type liquid level instrument which trips a pressure switch and sounds an alarm on the operating corridor panel when the sump is 2/3 full. A manually operated steam jet is then used to transfer the sump contents to the hot drain.

In the event the hot off-gas sump alarm failed to function, water would back up in the header until it reached the point where it would start draining in the existing Isotopes Area hot off-gas system to the hot drain. The maximum liquid head in the line under these conditions would be -14 in. which, being less than the normal -30 in. water gage on the header, would not completely shut off the flow of off-gas from equipment in the cells unless some other pressure-restricting device was in the line. All of the off-gas service outlets in the building are well above the maximum height to which liquid would rise in the header.

CELL VENTILATION SYSTEM

The building cell ventilation main header comes off the Isotopes Area header and enters the building on the southwest corner as a 36-in. concrete pipe. In the building, cell ventilation service is provided for all hoods both in the containment and noncontainment portions of the building, each of the four cells, and the vacuum pump pit. The pressure in the header is normally -4 to -6 in. water gage and the pressure in the cells is normally at least -1 in. water gage. The dampers on the hoods are manually adjusted to give a 100-ft/min face velocity when the hood is one-fourth open. Back-flow preventers are installed on all branches of the system except those serving the four cells.

Air leaving by way of selected radioactive hoods passes through a CWS-type absolute filter located in a housing on top of each hood and then goes to the Isotopes Area Filter Pit where it passes through a bank of roughing filters and a bank of CWS-type filters before going to the 3039 stack system. Air leaving by way of the chemical hoods and the vacuum pump pit is not locally filtered, but is filtered by the Isotopes Area Filter Pit before going to the stack system. Air leaving by way of the cells passes through high-efficiency filters in each cell and then goes through the roughing and absolute filters in the Isotopes Area Filter Pit before going to the stack system. Air entering the cells under normal operating conditions passes through 90% efficiency filters.

Normal air flow through cells A, B, C, and D is as follows:

Cell	LFM	CFM
A	195	782
B	168	671
C	99	396
D	120	480

Before a cell door is opened, one of the high-efficiency filters is removed from its sealed position to permit an increased air flow into the cell.

All filters, both in the building and at the Isotopes Area Filter Pit, have pressure-drop measuring instruments installed across them to indicate when changing is required.

The cell is considered as the primary containment for most beta and gamma work that is carried out in the building. All of the automatic control devices on the cell air-handling system are of fail-safe design with respect to a building electrical or instrument air failure. They will provide maximum cell ventilation capacity in the event of failure of these control services.

The vacuum pump exhaust is discharged into the cell ventilation system, and any gross contaminants are removed by the previously described surge tank and water-sealed pump.

The cell ventilation header is at an elevation below the Isotopes Area header and below the hot drain header. This problem is handled by providing a 6-gal sump in the low point of the line under cell D. The sump is equipped with an air purge level instrument which sounds an alarm on the operating corridor alarm panel when the sump is two-thirds full. A manually operated steam jet is used to empty the sump to hot drain. The hydrostatic head, which would exist if the sump alarm failed to function and the header filled with water, would be 18 in. water gage and would be sufficient to cut off cell ventilation. This is not considered a credible possiblity because a rapid buildup of water in the header cannot occur unless water is introduced directly into the cell ventilation opening in one of the cells. At the same time, there would have to be a cell ventilation duct pressure surge to close the backflow preventer on the duct serving the vacuum pump pit in order that the water would fill up the header rather than run back into the pump pit and sound the sump alarm.

SOLID WASTE

Radioactive solid wastes from the building consist of contaminated experimental apparatus, wipes, and small process vessels. Small items such as wipes, handling tools, and small glassware are placed in 1-gal waste cans and transported by the inter-cell conveyor to cell B. The can is then enclosed in plastic and placed in a waste transfer cask and transferred to the burial ground for disposal. Any item larger than 12 by 12 in. or weighing over 50 lb cannot be handled in the inter-cell conveyor and will have to be decontaminated in the cell to a point where it can be removed through the cell door or top plug and placed in a hot Dumpster. Before a cell door or top plugs are opened, health physics surveys are always made by using a long probe introduced through one of the plug sleeves or a survey meter introduced via the conveyor. All waste carriers are monitored and properly tagged by Health Physics before being

sent to the burial ground. The standards outlined in the Radiation Safety Manual are strictly followed. Alpha-contaminated wastes are bagged out of the alpha glove boxes before being placed in the approved containers.

Solid radioactive waste from Bldg. 3047 is handled according to ORNL CF 73-8-40 (Isotopes Division Solid Waste Handling Procedure and the Interim Procedure for Storage of Transuranium Solid Waste). These procedures are included in Appendix C.

PROCESS HAZARDS

Since Bldg. 3047 will not be used for any routine production operation, it is not possible to evaluate the hazards of specific processes which describe the activities being carried out from week to week.

Structurally, the cell block, including the windows, will withstand a sudden overpressure in excess of 600 lb/ft^2 without any type of failure or movement. The building structure will withstand a sudden overpressure of 5 psig without any massive failure and without damage to the emergency air-handling equipment and controls. Total hot off-gas capacity available to the building amounts to 600 ft^3/min. These building parameters along with others mentioned elsewhere in this report are used to establish the maximum quantities of chemicals that can be used in a particular experiment when the proposed experiment is reviewed. This review procedure, coupled with strict adherence to operating procedures, is expected to prevent any type of incident involving an unexpected chemical reaction.

Appendix A

DRAWINGS AND SCHEMATICS - BUILDING 3047

Fig. A-1	Building Plan
Fig. A-2	Evacuation Route and Plot Plan
Fig. A-3	Radioisotope Development Laboratory - Isometric
Fig. A-4	Cell Section - Typical Cells A, B, and D
Fig. A-5	Manipulator Cubicle Instrumentation - Room 110
Fig. A-6	Air Flow Pattern and the Location of Radiation-Protection and/or -Detection Equipment
Fig. A-7	Service Piping Schematic - Alpha Glove Boxes, Room 211
Fig. A-7A	Reference Information - Alpha Glove Boxes, Room 211

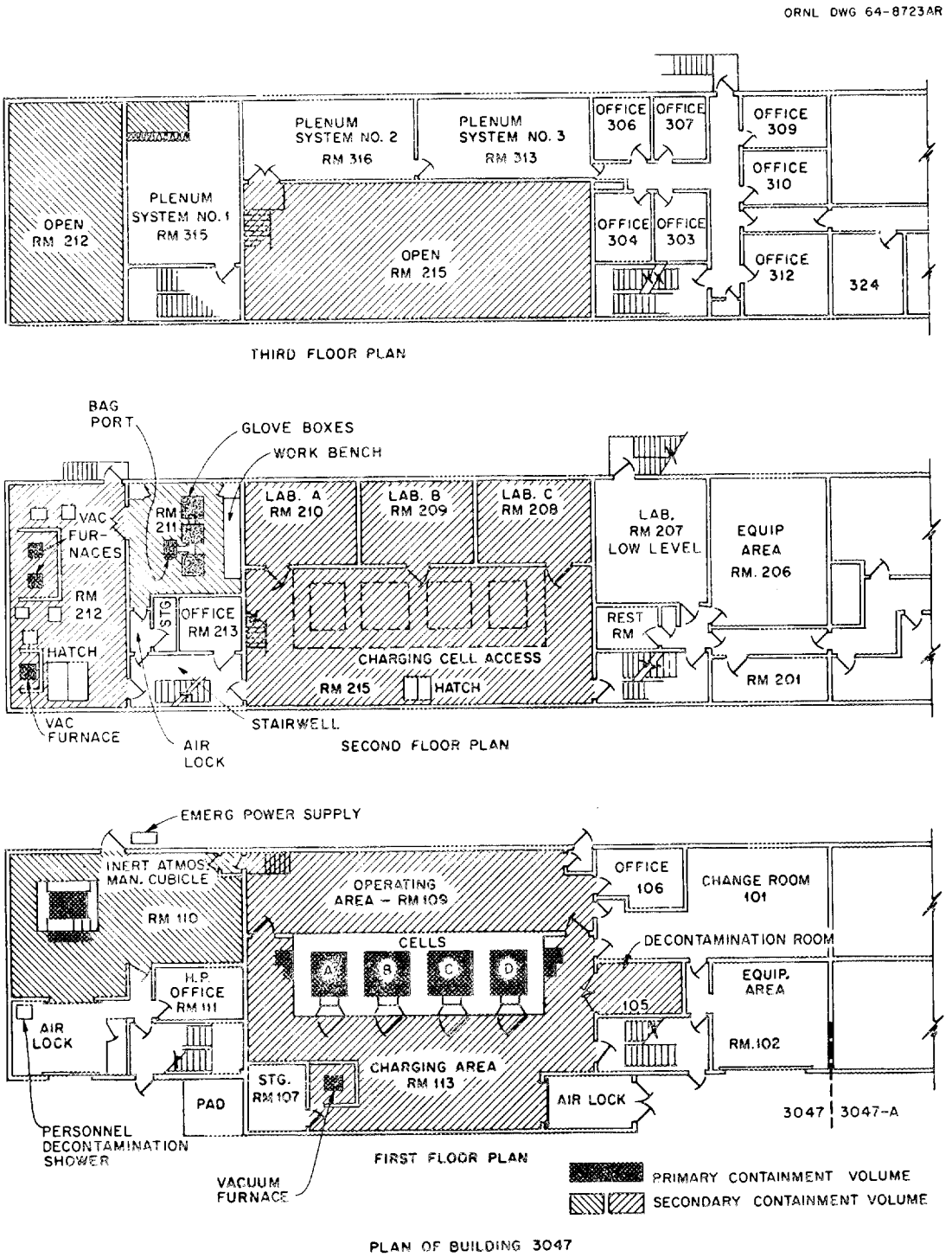


Fig. A-1. Building Plan.

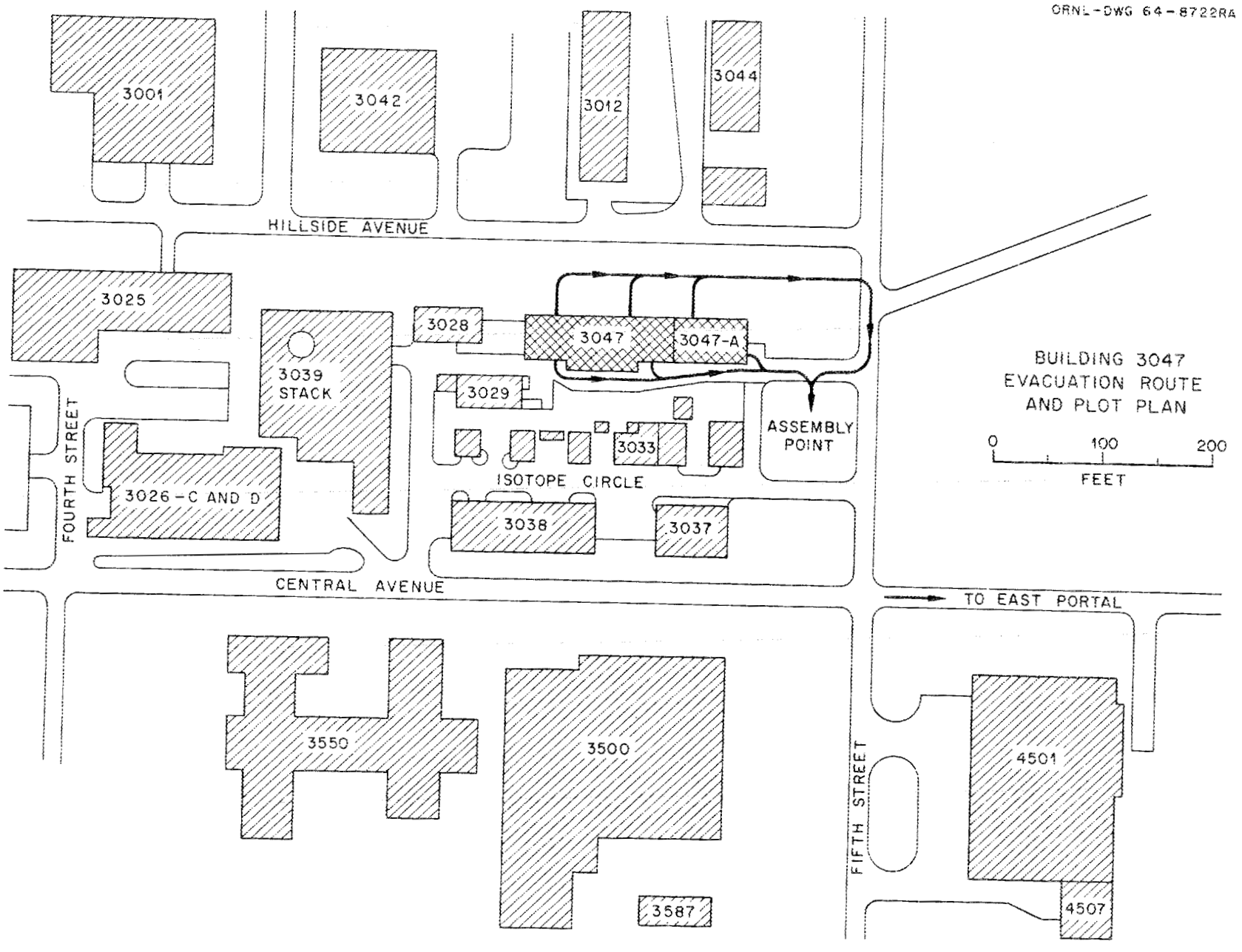
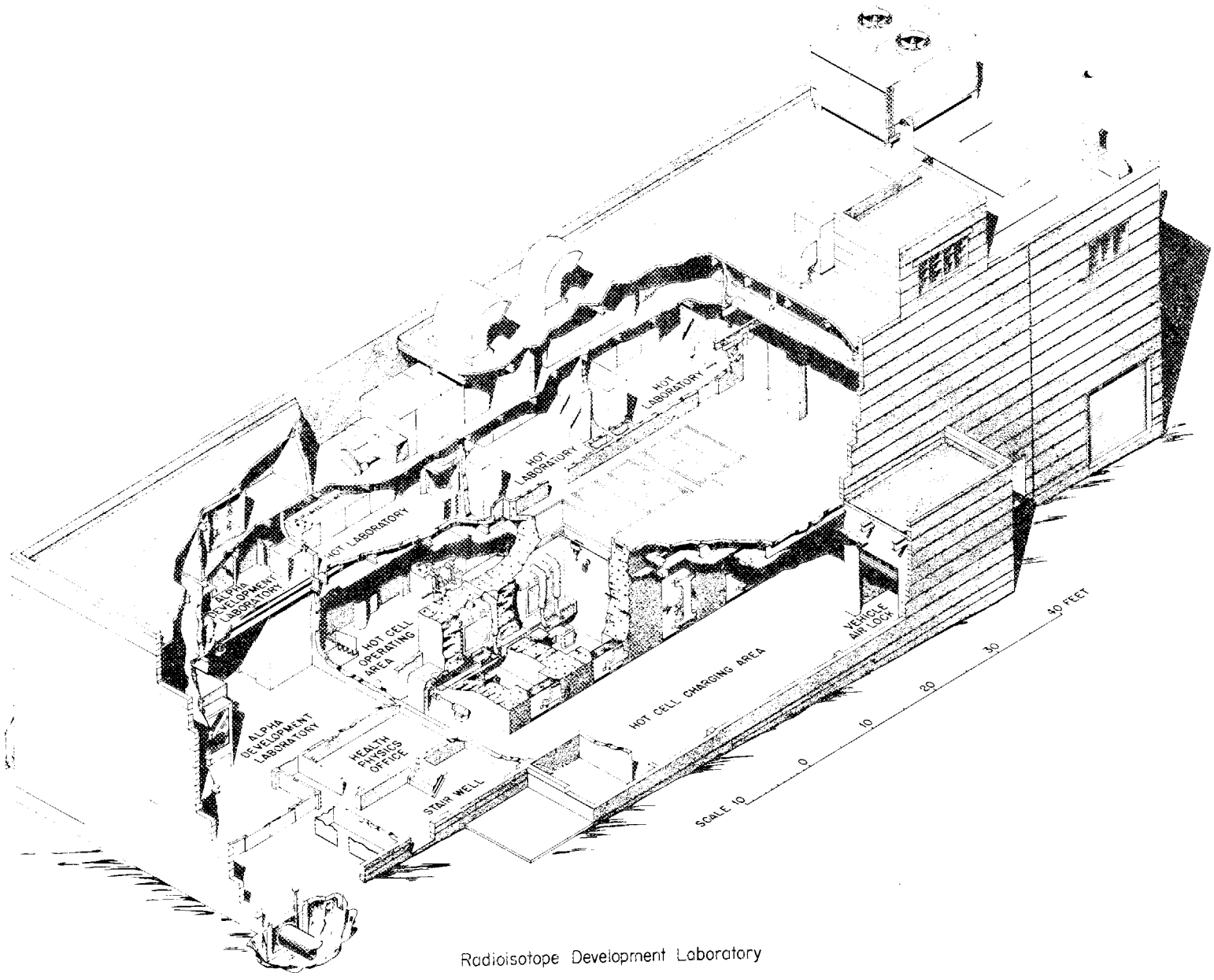


Fig. A-2. Evacuation Route and Plot Plan.

ORNL DWG 63-786R



Radioisotope Development Laboratory

Fig. A-3. Radioisotope Development Laboratory - Isometric.

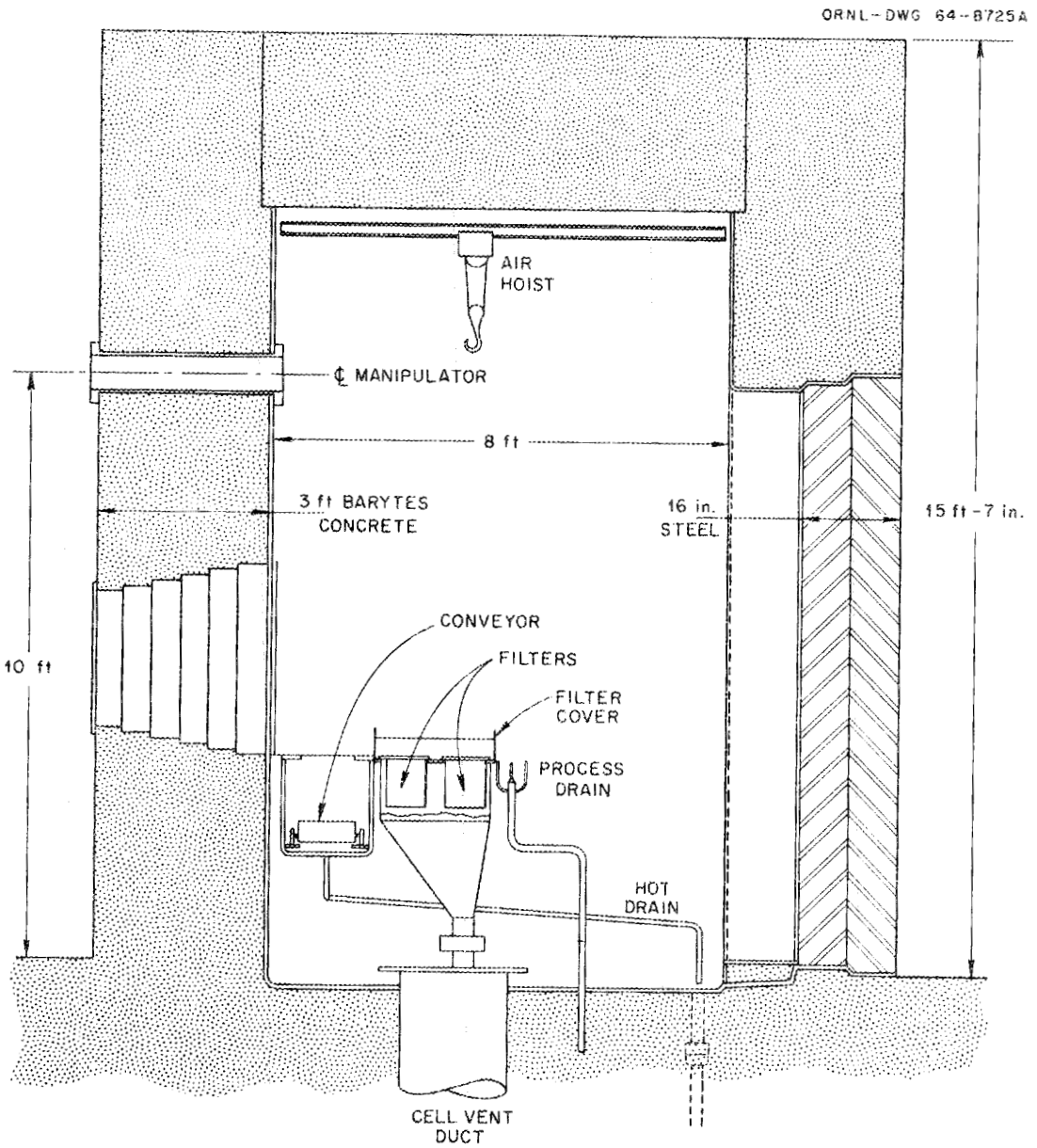


Fig. A-4. Cell Section - Typical Cells A, B, and D.

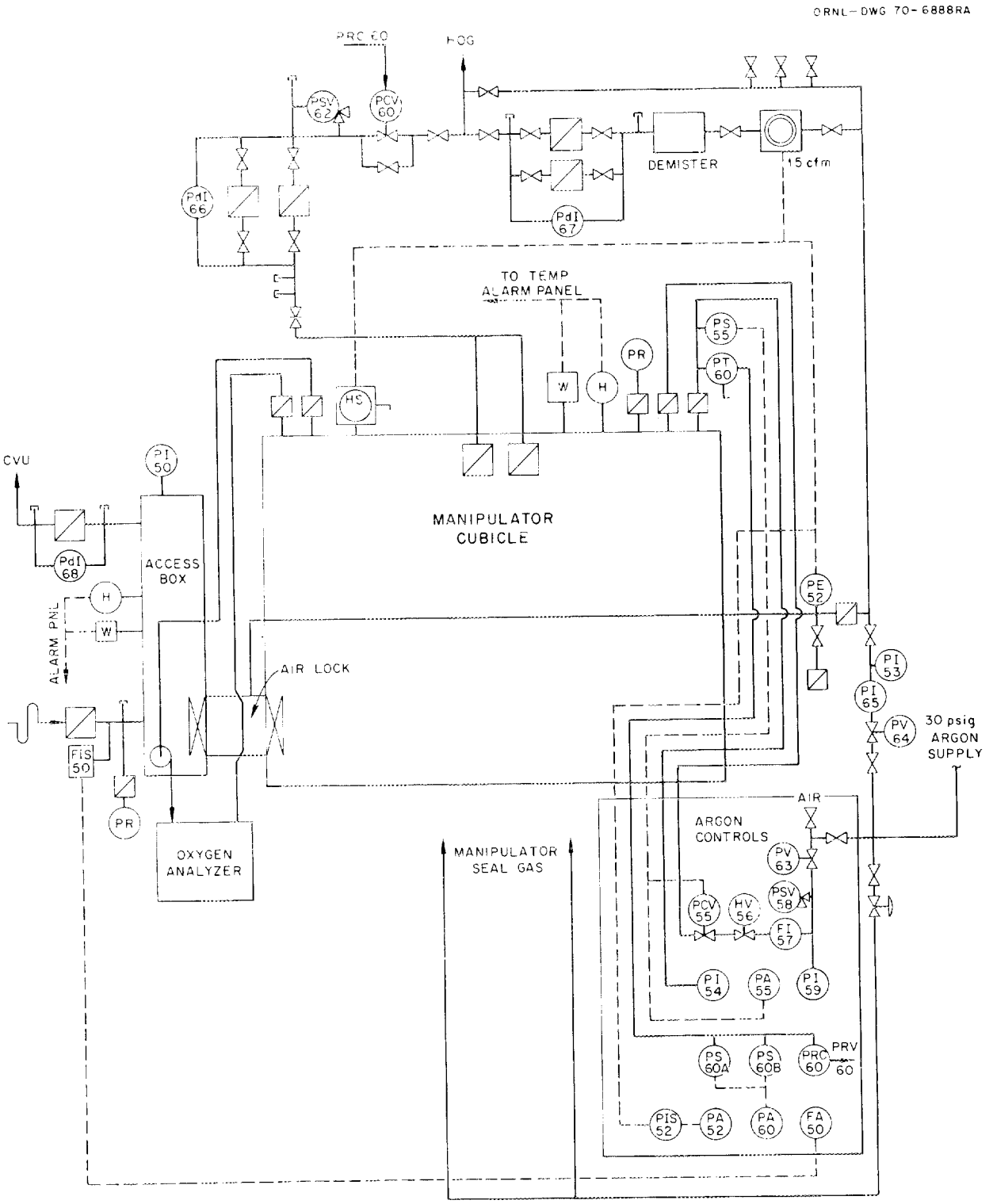


Fig. A-5. Manipulator Cubicle Instrumentation.

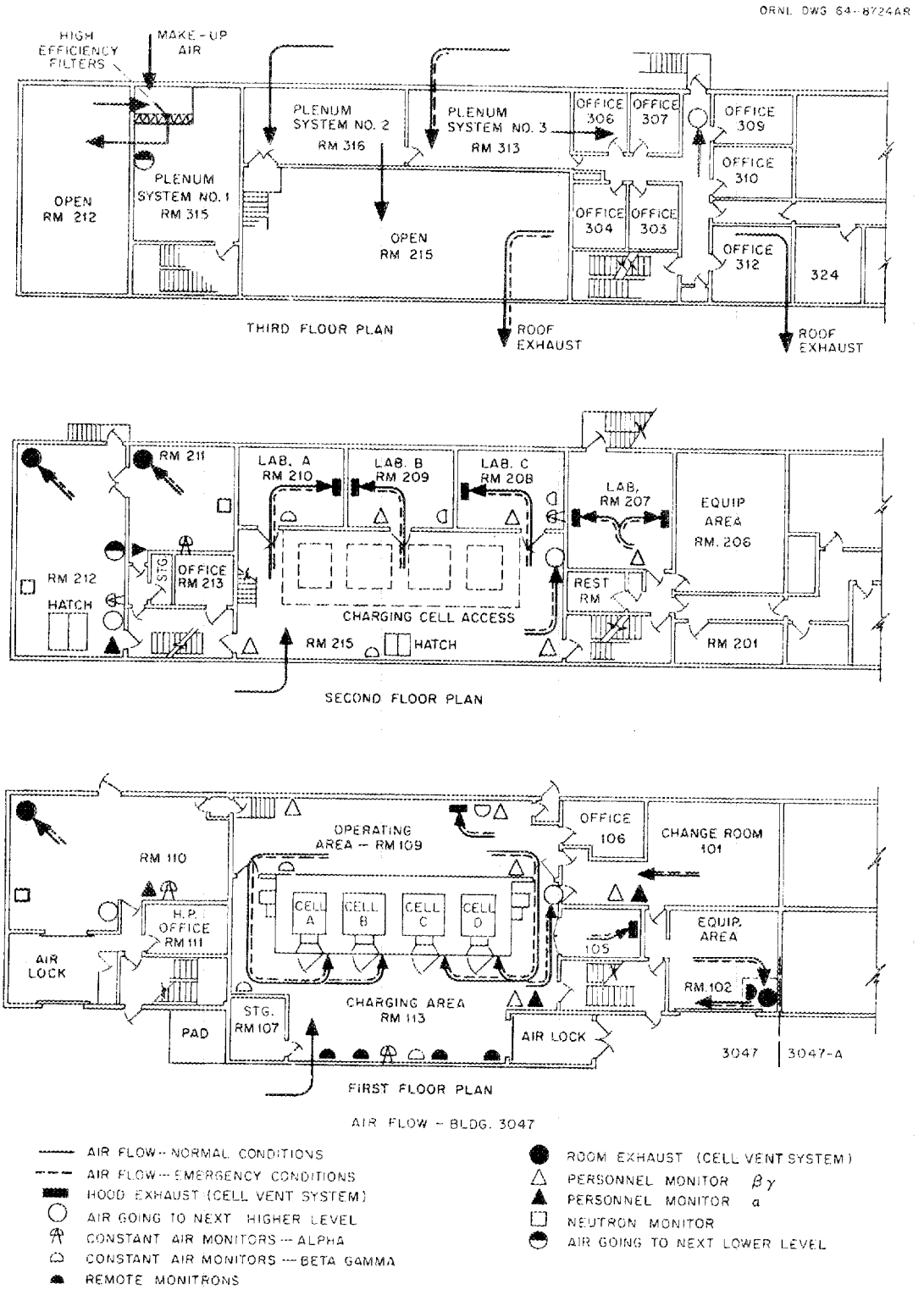


Fig. A-6. Air Flow Pattern and the Location of Radiation-Protection and/or -Detection Equipment.

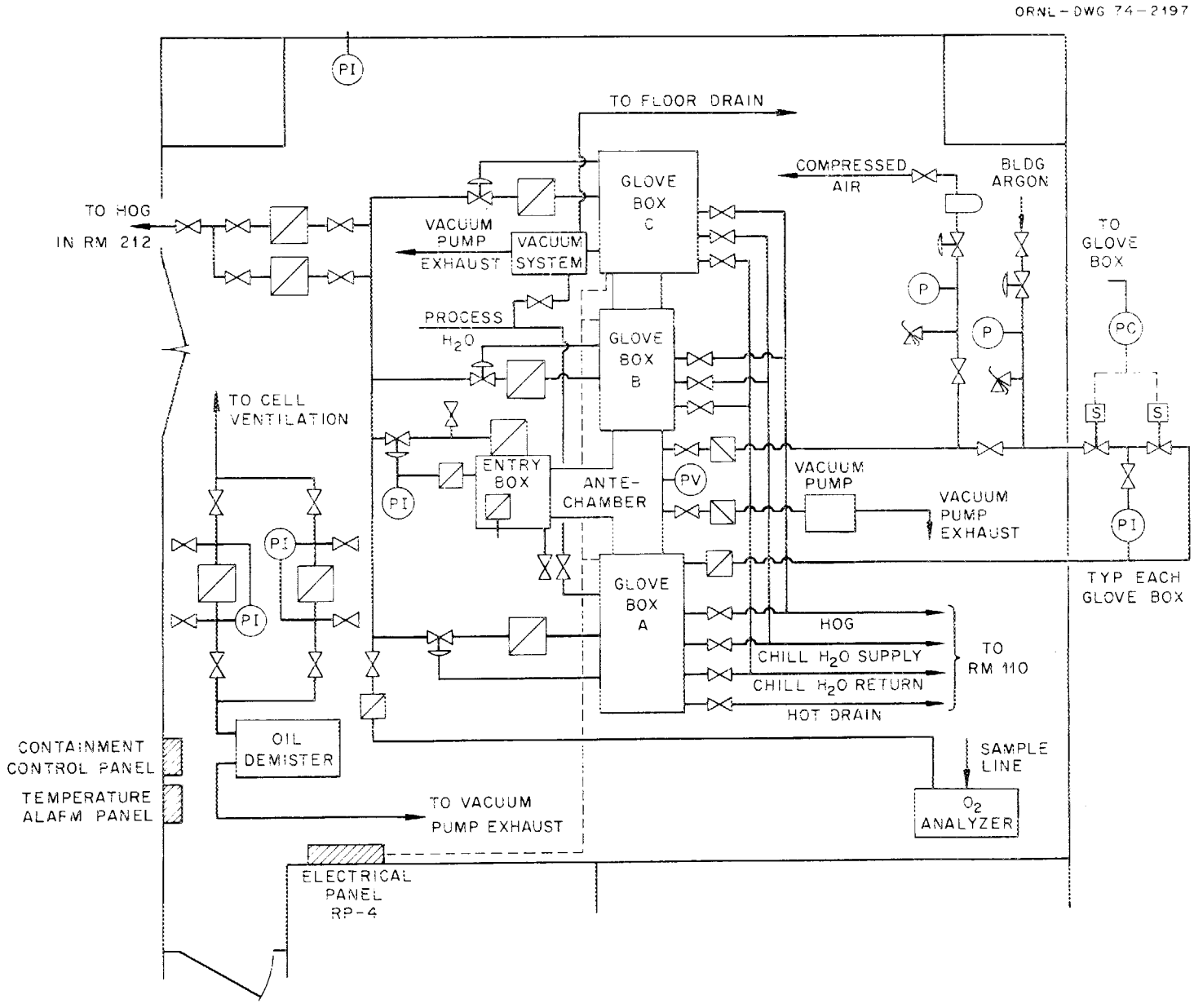


Fig. A-7. Service Piping Schematic - Alpha Glove Boxes, Room 211.

ORNL-DWG 74-2202

Alpha Glove Box Installation Building 3047, Room 211 — Reference Information

Sketch	Symbol	Description	Stores No.
SK1080A	P	Pressure Gage, 0–30 psig	
	PI	Pressure Indicator, Magnehelic, 0–4 in. wc, F. W. Dwyer	
	PC	Pressure Controller, Photohelic, 5 in.–0–5 in. wc, F. W. Dwyer	
	FI	Flow indicator, size 8	06-030-0100
	FS	Flow Switch, $^1/_2$ in. IPS	05-112-3957
	F	Heat Detector, 140F, Fenwal Detect-A-Fire, type 27121	
	PR	Pressure Relief Device (PYREX)	
		Filter, In-line, Absolute, $^1/_4$ in. IPS, MSA	
		Filter, HEPA, 50 cfm, rectangular (cylindrical)	07-645-5012 07-645-2675
		Filter, Prefilter	
		Electrical Receptacle, 230 VAC, 1 Φ	
		Electrical Receptacle, 115 VAC	
	FI	Flow Indicator, size 2	06-030-0125
		Flow Limiting Orifice	
	S	Solenoid Valve, $^1/_2$-in. orifice, $^1/_2$ in. IPS	07-896-2825
		Maxitrol Control Valve, 2 in. IPS, Model 210-DZ	
		Snap Tite Coupling, Female, $^3/_8$ in. IPS, SVALC-6	07-207-5317
	W	Water Level Detector, Honeywell Versa-Tran	06-020-1625
SK1081A	PV	Pressure-Vacuum Gauge, 30 in. Hg–15 psig	
		Pressure Regulator, Non-Bleeding, 0–50 psig	
		Relief Valve, 0–10 psig, $^1/_8$ in. IPS	
		Compressed Air Filter	

Fig. A-7A. Reference Information - Alpha Glove Boxes, Room 211.

Appendix B

CONTAINMENT SYSTEM TEST PROCEDURE

Containment System Testing

Weekly Test

1. Advise building personnel over the speaker system that the containment system is being tested.

2. Put the building in containment using the manual button in the southeast stairwell and check the following items:

   a. The pressure in the cell-operating and access areas drops to at least -0.3 in. water gage within 20 sec or less.

   b. The audio and visual alarms in the operating area are functioning. Silence the audio alarm.

   c. The pressure in the operating and access areas does not drop lower than -0.55 in. water gage.

   d. The air supply fan in plenum 2 has stopped operating.

   e. The damper on the plenum 2 air supply duct is closed.

   f. The air supply fans in plenum 1 and 3 are still operating.

   g. All roof exhaust fans have stopped operating except AJ-102A or AJ-102B.

   h. The cell negative pressure gage shows at least -0.5 in. water gage with respect to the operating area and is not more than -2.0 in. water gage.

3. Put the building back in the normal operating condition by pushing the reset button on the operating corridor panel.

4. Put the building back in containment by alarming two CAM's at the same time.

5. Put the building back in normal operating condition.

If any of the above items are not operating properly, notify the building supervisor.

Quarterly Test

Once each quarter, in addition to the items listed above, put the building into containment by loosening the low-pressure connection to the containment pressure switches located on the operating face of the cells. Do this for each cell.

Building 3047 Containment Checklist

Date _____ Checked by _____

1. Method used to place building in containment: _____

2. Operating area: Seconds to reach -0.3 in. water gage . . . . _____

3. Charging area: Seconds to reach -0.3 in. water gage . . . . _____

4. Final w.g. negative pressure reached: Operating Area . . . . _____
   Charging Area . . . . _____

5. Alarms operating:

   a. Air handling panel . . . . . _____
   b. Edwards annunciator . . . . . _____
   c. Southeast stairwell - 2nd floor . . . . . _____
   d. Southwest stairwell - 2nd floor . . . . . _____
   e. Room 215 . . . . . _____
   f. Room 113 . . . . . _____

6. Lights operating:

   a. Air handling panel . . . . . _____
   b. Personnel access from Room 110 . . . . . _____
   c. Personnel access from southwest stairwell - 2nd floor . . _____
   d. Personnel access from southeast stairwell - 2nd floor . . _____
   e. Personnel access from southeast stairwell - 1st floor . . _____
   f. South air lock - inside . . . . . _____
   g. Personnel access from change room to containment area . . _____
   h. Personnel access to operating area from north side of building . . . . . _____
   i. Access from 3rd level - Room 313 . . . . . _____

7. Supply fan No. 2 stopped . . . . . _____

8. Supply fan No. 2 inlet damper closed . . . . . _____

9. Supply fan No. 1 operating . . . . . _____

10. Supply fan No. 3 operating . . . . . _____

11. Exhaust fan AJ-106 off . . . . . _____

12. Cell w.g. negative pressure:

    a. Cell A . . . . . _____
    b. Cell B . . . . . _____
    c. Cell C . . . . . _____
    d. Cell D . . . . . _____

Appendix C

BUILDING 3047 OPERATING PROCEDURES AND REGULATIONS

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CELL ENTRY THROUGH REAR ACCESS DOOR

1. Store all radioactive materials in appropriate shielded casks or adjoining cells. Place waste and debris in metal cans and remove or store.

2. Hose down cell interior with water. Allow 15 min for cell to drain.

3. Check inside of cell with an in-cell survey meter probe. Enclose probe in plastic sleeve and insert through access sleeve from rear of cell. Remove probe when survey operation is complete.

4. Check cell smear level with wet paper towels via conveyor access cubicle. Must be less than 20 mr/hr before opening cell access door.

5. Remove one cell exhaust filter to increase air flow.

6. Position conveyor dolly at either cubicle E or W. Choose cubicle that is the greatest distance from the cell to be opened.

7. Set up rope supports around cell doorway with appropriate radiation and/or contamination signs attached to the rope.

8. Spread and tape blotter paper over floor inside roped-off area.

9. Provide separate plastic-lined receptacles for used coveralls and caps, gloves and bootees, masks, and waste.

10. Prepare decontamination procedure and/or Radiation Work Permit (Form UCN-2779). The procedure shall include reagents (concentration and volume) to be used, method of application, removal of equipment, disposition of equipment, potential hazards, etc.

11. Due to the effort required to open the cell doors, two men shall perform the operation. One man is to open the door, and the other man is to operate a cutie-pie survey meter. "C" zone clothing and masks are required while opening a cell door.

12. Determine radiation levels in the cell and on the door (cutie-pie survey meter and smears) and consult cell supervisor if radiation is above 500 mr/hr and smears are above 20 mr/hr.

13. Cell entry for the purpose of decontamination, equipment installation, equipment removal, or equipment repairs involving the use of or possible contact with radioactive solutions or solids shall require the following protective clothing:

    Assault mask
    Two pairs contamination coveralls
    2 pairs plastic bootees (taped to coveralls)
    2 pairs rubber gloves (taped to coveralls)
    Safety shoes
    Cotton or plastic hood (taped to coveralls)
    Film badge, pencil meters, chirper, dosimeter, and film ring

14. The following protective clothing shall be considered the minimum requirement for cell entry:

    Contamination coveralls
    Cotton or rubber gloves (taped to coveralls)
    Shoe covers
    Plastic bootees (taped to coveralls)
    Safety shoes
    Cotton cap or hood
    Film badge, pencil meters, chirper, dosimeter, and film ring
    Assault mask

15. When personnel are working inside a cell, at least one man must be available outside the cell to assist with timekeeping, dressing, undressing, etc. and have the minimum requirement protective clothing available for emergency cell entry.

16. In-cell Procedure

    a. Check all suspicious material with a portable radiation detector.

    b. Do not remove anything by hand before checking with a survey meter. Use tongs, pliers, extended brushes, or any other device which will keep the hands and body in radiation fields <5 R/hr.

    c. All contaminated materials removed from cells shall be bagged and taped, placed in metal or plywood containers, and tagged for disposal.

    d. Work at a normal speed. Do not become excited as this requires a greater air supply and generally means a departure from safe work habits.

CELL ENTRY THROUGH TOP PLUGS

1. Store all radioactive material in appropriate shielded casks or adjoining cell. Place waste and debris in metal cans and remove or store.

2. Hose down cell interior with water. Allow 15 min for cell to drain.

3. Check inside of cell with an in-cell survey meter probe. Enclose probe in plastic sleeve and insert through access sleeve from rear of cell. Remove probe when survey operation is complete.

4. Check cell smear level with wet paper towels via conveyor access cubicle. Must be less than 20 mr/hr before opening cell access plugs.

5. Remove one cell exhaust filter to increase air flow.

6. Position conveyor dolly at either cubicle E or W. Choose cubicle that is greatest distance from the cell to be opened.

7. Set up rope supports around the cell to be entered with necessary radiation and contamination signs attached to the ropes. Note: When opening cells B or C, notify personnel in Laboratory B of changing conditions near the laboratory access door.

8. Place and tape down blotter paper inside the roped-off area except over the cell blocks to be removed.

9. Set up rope supports around area where cell blocks are to be stored. Attach appropriate radiation or contamination signs to the ropes. Place and tape down blotter paper inside the roped-off area.

10. Provide separate plastic-lined receptacles for used coveralls and caps, gloves and bootees, and masks and waste.

11. Prepare decontamination procedure and/or Radiation Work Permit (Form UCN-2779). The procedure shall include reagents (concentration and volume) to be used, method of application, removal of equipment, disposition of equipment, potential hazards, etc.

12. Remove the 6-in. diameter plug from the cell blocks. Survey (wipe if necessary) and wrap it in plastic. Place it on paper in roped-off area.

13. Obtain survey of cell interior through plug opening and contact manipulator cell supervisor concerning cell block removal.

14. Wear "C" zone clothing during block removal including assault mask, gloves, and shoe covers. Also, wear chirper, PRM, pencil meters, and film badge.

15. Due to the effort required to operate the hoist and guide the blocks, two men shall perform the operation — one man to remove the blocks and the other to handle the survey meter.

16. Survey underside of each block and take four spot smears to determine transferable contamination. Consult manipulator cell supervisor for specific handling instructions. Decontaminate to <5000 dis/min if necessary.

17. Wrap each block in double plastic sheet and place within roped-off area.

18. Cell entry for the purpose of decontamination of equipment, equipment removal, or equipment repairs involving the use of or possible contact with radioactive solutions shall require the following protective clothing:

    Assault mask
    2 pairs contamination coveralls
    2 pairs plastic bootees (taped to coveralls)
    2 pairs rubber gloves (taped to coveralls)
    Safety shoes
    Cotton or plastic hood (taped to coveralls)
    Film badge, pencil meters, chirper, dosimeter, and film ring

19. The following protective clothing shall be considered the minimum requirement for cell entry:

    Contamination coveralls
    Cotton or rubber gloves (taped to coveralls)
    Shoe covers
    Plastic bootees (taped to coveralls)
    Safety shoes
    Cotton cap or hood
    Film badge, pencil meters, chirper, and dosimeter
    Assault mask

20. When personnel are working inside a cell, at least one man must be available outside the cell to assist with timekeeping, dressing, undressing, etc. and have the minimum requirement protective clothing available for emergency cell entry.

21. In-Cell Procedure:

    a. Check all suspicious material with a portable detector.

    b. Do not remove <u>anything</u> by hand before checking with a survey meter. Use tongs, pliers, extended brushes, or any other device which will keep the hands and body in radiation fields <5 R/hr.

    c. All contaminated materials removed from cells shall be <u>bagged</u> and <u>taped</u>, placed in metal or plywood containers, and <u>tagged</u> for disposal.

d. Work at a normal speed. Do not become excited as this requires a greater air supply and generally means a departure from safe work habits.

HANDLING AND STORAGE OF RARE AND VALUABLE MATERIALS

1. Each unit (source, capsule, bottle, etc.) shall be stored in a container that is identified by a label of yellow tape and a number. The number shall appear in at least three places (∿120° apart) along with the words PRODUCT STORAGE CAN.

2. A card shall be filled in with the following information:

   a. Date
   b. Radioactive material, form and amount (curies, grams, etc.)
   c. Radiation survey measurement (if available)
   d. Product storage can number
   e. Signature

3. The card shall be displayed at the operating face of the cell where the material is stored. If the material is moved to another cell, the card shall be displayed at the new location with the transfer noted.

4. Entries shall be recorded in the Cell Log Book. (A separate book is available at each cell for all operations affecting the transfer, storage, processing, handling, or disposal of product materials.) Entries shall include the date and time of the operation and the signature of the person performing the operation.

5. All product storage cans must be inventoried each day and recorded in the log book. Also, each can must be accounted for before waste transfers to the burial ground are made. When it becomes necessary to retire a product storage can, a description of the disposition must be recorded in the log book.

INTER-CELL CONVEYOR — OPERATING PROCEDURE

Description

The conveyor consists of a cable-operated, motor-powered, 4-wheeled dolly that travels in an enclosure from Cubicles E and W at each end of the cell block through cells A, B, C, and D. Design limitations for the dolly include a maximum weight of 50 lbs and a maximum size of 12 × 12 × 12 in.

The conveyor may be operated from each of six stations — Cubicle E (east end), Cubicle W (west end) and cells A, B, C, and D (reading west to east). Limit switches stop the dolly at the desired station. Indicator lights show the dolly location. Each of the cell stations is equipped with the following:

1. Indicator light (red) — Light burns when conveyor is running.

2. Turn-button switch — Left position locks out conveyor. Right position allows conveyor to be moved.

3. Center push button — Activates conveyor to move to that selected location.

4. Left jog button — Permits moving conveyor to left.

5. Right jog button — Permits moving conveyor to right.

6. Cubicles E and W have indicator lights for each of the four cells at each of the cubicles to show the location of the dolly. Incandescent lights (6) above the cell operating face also show the location of the dolly.

Safety switches automatically lock out the drive mechanism when two cell doors, two roof plugs, or one each cell door and roof plug in separate cells are open. Also, the lock-out mechanism is activated when an attempt is made to run the dolly through one cell which has an open door or open roof plug. If the dolly is in either cubicle with an adjoining cell door or roof plug open, the dolly will not move.

The conveyor relay control panel is located on the north wall of Room 109. External controls on the panel include the following:

1. Horn — Sounds to indicate abnormal condition.

2. Light — Indicates dolly stopped east of cell.

3. Light — Indicates dolly stopped west of cell.

4. Lock-out switch (five position) — Normal, cell A, cell B, cell C, and cell D.

5. Key Lock — Key must be used to change position of lock-out switch. (Bldg. 3047 supervisor must be notified before switch is moved from normal position.)

The conveyor drive mechanisms located outside of each of the two cubicles are equipped with electrical braking systems through a magnetic clutch arrangement to keep tension on the drive cable when the dolly is moving in either direction. If the conveyor fails to operate, check clutches for proper operation. In case of an emergency, the magnetic brake can be disengaged and the drive shaft turned by hand at either of the two cubicles. The motor drive units are examined and serviced annually by the P&E Division on the routine maintenance program.

Operation

1. Observe location of dolly and check with other operating personnel to be sure dolly is available. Examine dolly visually to be sure dolly is empty.

2. (a) Conveyor relay panel — Lock-out switch should be at N (normal) position.
   (b) Cell and cubicle switches — All switches should be in the stop position.

3. To move dolly from one position to another, proceed to the desired cell destination and press the center button.

4. When indicator light comes on at the destination, remove access cover in the appropriate cell and check position of dolly. The dolly may be moved to the right or left by pressing one of the jog buttons. The position of the dolly in the two access cubicles may be checked through the shielded viewing windows.

5. When placing material on the dolly always check the dolly after loading to be sure that the dolly is properly loaded for transfer. A loss of material from the dolly between stations can result in a time-consuming recovery operation.

6. CAUTION — The following precautions must be taken when it is necessary to remove the covers from the access cubicles:

   a. A radiation survey instrument (cutie pie) in good working condition must be used to monitor cubicle opening.

   b. The access cover in one of the four cells must have one end raised ∿1 in. to provide additional air flow through the opening.

   c. A gas mask or Comfo mask and "C" zone clothing must be worn.

d. The area around the cubicle must be roped off as a potential contamination zone, and blotter paper must be placed on the floor. The zone must be maintained until the operation is complete and the area is cleared for routine access.

7. If difficulty is encountered with the conveyor, contact the Bldg. 3047 supervisor.

RADIOACTIVE SOLID WASTE HANDLING AND DISPOSAL

All solid radioactive waste except transuranium solid waste will be packaged and handled according to No. 5.1, "Disposal of Solid Radioactive Wastes," of the Procedures and Practices for Radiation Protection, Health Physics Manual. Low-level waste may be placed in plastic-lined hot cans for transfer to a yellow Dumpster or, by special request, may be sent directly to the Burial Ground (see Hot Can Handling Procedure).

The manipulator cell supervisor shall be consulted concerning the decontamination, packaging, cask procurement, cask loading, and cask removal operations.

Form UCN-2822, Request for Transfer of Contaminated Material to Burial Ground, shall accompany all shielded cask or special transfers to the Burial Ground from Bldg. 3047. A Radiation Work Permit, Form UCN-2779, shall be executed as required (see Procedures and Practices for Radiation Protection, Health Physics Manual, No. 3.2).

Five types of shielded transfer casks are available for use in Bldg. 3047 to transport high-level and intermediate-level beta and gamma waste to the Burial Ground. One type of shielded cask (two available) is a shielded Dumpster with approximate inside dimensions as follows:

23 by 68 in.	at bottom
44 by 68 in.	at top
28 in. at back 32 in. at front	height
30 ft^3	approximate volume

The material of construction is steel and the shielding is 1-in.-thick lead. Arrangements for the cask may be made through the Burial Ground foreman, telephone 3-6356.

The second type of shielded cask (two available) is a shielded Dumpster with approximate inside dimensions as follows:

20 by 38 in.	at bottom
37 by 38 in.	at top
24 in. at back 16 in. at front	height
10 ft^3	approximate volume

The material of construction is stainless steel and the shielding is 4 in. of lead. One of the casks is stored in Bldg. 3029, and the other is stored at the Fission Products Development Laboratory.

The third cask accommodates a one-gallon can and is designed for top or bottom loading and for bottom discharge. The shielding is 4-in.-thick lead. Cans may be introduced and removed from conveyor cubicles A or B with the cask. After the cask is loaded and the drawer is locked in

the closed position, it shall be enclosed in two or more layers of heavy plastic sheet and placed in a metal tray for transfer to the Burial Ground. The cask must be secured on the transport vehicle to prevent lateral or vertical movement.

The fourth type of shielded cask is the Pierce cask. It is designed for top loading and is emptied by tilting to an inverted position and allowing the waste packages to slide out. The shielding is 8-in.-thick lead, and the cavity size is 12 in. diam by 24 in. high. The weight of the cask is ∿10,000 lb.

The fifth type of cask is the Schaich cask. It is designed primarily for transporting radioactive waste and materials from the Isotopes Area to the Fission Products Development Laboratory. The shielding is 6-in.-thick lead, and the cavity size is 12 in. diam by 18 in. high.

All transuranium solid waste will be packaged and handled according to the "Interim Procedure for Storage of Transuranium Solid Waste," No. A-9 in the Procedures and Practices for Radiation Protection, Health Physics Manual.

HOT CAN HANDLING PROCEDURE

1. Cans reading <200 mR/hr will be placed in the shielded Dumpster at the east end of the Isotopes Area by operating personnel. Place radiation tags or signs on cans in use reading >6 mR/hr.

2. Cans reading >200 mR/hr must be handled on a special pickup basis (call Burial Ground, 3-6356, to arrange for special pickup).

3. Use only "Approved for Use" tagged empties equipped with a plastic bag liner.

4. The Zoning Procedure is always in effect.

5. Personnel in Bldg. 3047 are responsible for the following:

   a. Taping the bags closed
   b. Monitoring and tagging all cans
   c. Taping covers on all cans for Burial Ground pickup
   d. Placing cans in proper location for pickup

MANIPULATOR CHANGE-OUT PROCEDURE

1. Remotely decontaminate manipulator

2. Remotely de-tong manipulator to be removed

3. Spread and tape down blotter paper in front of cell

4. Drape plastic sheet down the front face of cell

5. Rope off operating area

6. NOTE: When extremely hazardous contamination is suspected, an announcement should be made over the PA system, and the building should be put into containment condition.

7. Obtain Radiation Work Permit.

8. Minimum protective clothing requirements are:

   Coveralls
   Shoe covers
   Gloves
   Assault mask
   Cap

9. Millwright will proceed with normal manipulator removal procedure, which includes bagging in plastic as it is removed. Health Physics representative will be in attendance continually during manipulator removal.

10. After removal, radiation permitting, a smear should be taken on the slave end of the manipulator by carefully cutting the plastic covering and resealing after the smear is taken.

11. Decontamination procedure will be determined by the above smear.

12. After manipulator is replaced, all paper and plastic should be picked up, and the entire operating area should be smeared and cleaned if necessary.

13. If building was put into containment for removal of manipulators, return the building to normal conditions.

VACUUM SURGE TANK DRAINING

1. The annunciator in Room 109 and vacuum pit panelboard will sound an alarm when F-104 has a liquid level of ∿7 in. Acknowledge both alarms.

2. Shut down vacuum system by stopping vacuum pump (J-101).

3. Bleed off vacuum in F-104 to atmosphere by opening bleed valve at vacuum pit panelboard.

4. Open HCV-104.

5. Open steam to J-108 (steam jet) (HS-108).

6. Allow jet to run until TI-108 indicates that F-104 is empty. Turn off steam.

7. Close HCV-104.

8. F-104 should be rinsed with H_2O each time it becomes necessary to empty tank under normal operations.

9. To rinse F-104, start vacuum system and add H_2O through bleed valve at panelboard until the level alarm sounds.

10. Repeat steps 2 through 7.

11. Start vacuum pump.

12. Reset all alarms.

VACUUM SEAL WATER TANK DRAINING

1. Shut down vacuum system by stopping vacuum pump (J-101).

2. Open HCV-105.

3. Turn on steam to J-108.

4. Continue jetting until TI-108 indicates that F-105 is empty.
   NOTE: Low-level alarm will sound.

5. Close HS-108.

6. Close HCV-105.

7. Add H_2O to F-105 through valve at panelboard until level alarm on F-195 is in normal condition.

8. Start J-101.

9. Reset all alarms.

VACUUM PIT ENTRY

1. A Health Physics surveyor should be in attendance at all times when entry into the vacuum pit becomes necessary.

2. If at all possible, the vacuum system should be shut down, and F-105 and F-104 should be rinsed as per Vacuum Surge Tank Draining Procedure.

3. Set up contamination zone around access port.

4. Pull manhole cover from vacuum pit access port.

5. Have Health Physics survey carefully from top of port.

6. Health Physics surveyor will survey and spot-smear vacuum pit; this survey and smear procedure will determine protective clothing to be worn.

HOT OFF-GAS AND CELL VENTILATION SUMP JET OPERATION

Description

Two sumps are located inside cell D to drain the hot off-gas and cell ventilation ducts. Each sump has a separate steam jet syphon which empties into a 10-gal stainless steel discharge tank. The process valves in the system are remotely operated bellows-sealed valves. The controls are located on the operating face of cell D.

High-level pressure switches for each sump are located on the face of cell D, and the alarm is connected to the Edwards Annunciator Panel in the cell operating area.

When the alarm is activated, acknowledge the audible alarm and proceed with the following operations:

1. Cell Ventilation Sump

    a. Close valves 1 and 5
    b. Open valve 2
    c. Open valve 4
    d. Open manual steam valve labeled STEAM TO CELL VENTILATION SUMP JET
    e. Allow steam to flow for ∿1 min after alarm light goes off
    f. Close manual steam valve
    g. Close valve 4
    h. Close valve 2
    i. Open valves 1 and 5; observe flow from tank to drain

2. Hot Off-Gas Sump

    a. Close valves 1 and 5
    b. Open valve 2
    c. Open valve 3
    d. Open manual steam valve labeled STEAM TO H.O.G. SUMP JET
    e. Allow steam to flow for ∿1 min after alarm light goes off
    f. Close manual steam valve
    g. Close valve 3
    h. Close valve 2
    i. Open valves 1 and 5; observe flow from tank to drain

VACUUM PIT PANELBOARD

1. Acknowledge alarm at Edwards Annunciator and then at vacuum pit panelboard.

2. The following items could cause alarm:

   a. Surge Tank High Level

      Correction — contact one of the persons mentioned in 3. for instructions.

   b. Vacuum Pit Sump High Level

      Correction — open HS-101 vacuum sump drain valve. Open HS-108 steam to jet valve. Allow steam jet to operate until temperature indicator on TI-108 shows a rise in temperature. Close HS-101 and HS-108.

   c. TA-101, TA-108, TA-101A, TA-103, and TA-105

      Correction — check Wheelco Controllers and note which is causing alarm.

      TA-101 Vacuum Pump South Bearing Case Temperature - contact one of the persons mentioned in 3. for instructions.

      TA-108 Jet Discharge Temperature - check HS-108 (steam to jet) valve to make sure that it is closed.

      TA-101A Not operating

      TA-103 C-103 Heat Exchanger H_2O Discharge Temperature - increase flow through cooling H_2O rotometer by opening manual valve located just behind rotometer.

      TA-105 Seal H_2O Temperature - increase flow through cooling H_2O rotometer by opening manual valve located just behind rotometer.

   d. Seal H_2O Tank (F-105) Low Level

      Correction — add H_2O to F-105 by manual valve located behind panelboard until alarm returns to normal condition.

   e. Seal H_2O Tank (F-105) High Level

      Correction — open HS-105 valve, open HS-108, and allow jet to operate until alarm returns to normal.

3. For further information contact:

W. G. Tatum	Lenoir City	986-8649
E. E. Pierce	Kingston	376-6316
E. E. Beauchamp	Oak Ridge	483-7088

CONTAINMENT PROCEDURE

1. In the event the building should be in containment, designated lights at each entrance to the containment area will be flashing, and an intermittent sounding horn can be heard in each stairwell and also in the operating area. Push horn reset button in center stairwell to silence horn. Lights will continue to flash.

2. Call Health Physics.

3. Check radiation monitor panel in southeast stairwell to see if containment was caused by a radiation incident.
   NOTE: It takes two air monitors alarming simultaneously to cause building to go into containment.

4. If radiation has caused building to go into containment, have Health Physics "dress out" in appropriate protective clothing and enter the containment area to survey the situation.

5. After survey has been completed, contact one of the persons listed in 10. for further instructions.

6. If radiation did not cause the building to go into containment, enter operating area and press Alarm Reset button on Air System Control Panel and on Edwards Annunciator. This will stop all horns. Flashing lights will continue to operate until Air System is reset and building is back in normal condition.

7. If power failure caused containment, follow Power Failure Correction Procedure in Bldg. 3047 Procedure Manual.

8. Check pressure differential between cells and operating area. A differential of -0.25 water gage will cause building to go into containment. Note which cell or cells caused containment and contact one of the persons listed in 10.

9. To reset containment and return building to normal condition after the cause has been corrected, do the following:

   a. Press "Reset" button on Air System Control Panel.
   b. Start AJ-106 at Motor Control Center in Room 102. AJ-102A should be running.

10. For further information contact:

W. G. Tatum	Lenoir City	986-8649
E. E. Pierce	Kingston	376-6316
E. E. Beauchamp	Oak Ridge	483-7088

PLANT EVACUATION PROCEDURE

Immediately upon hearing the Plant Evacuation signal, the following operations will be performed:

1. Shut down all operations possible. Turn out lights in laboratories and offices.

2. The searchers will search their assigned areas, alerting and evacuating all personnel.

3. Evacuation route follows Isotope Circle to 5th Street to Central Avenue to East Portal.

4. After making a search of the building, the searchers will report to the building warden at the southeast stairwell, first floor.

SAFETY REGULATIONS

Protective Clothing and Equipment

1. Protective Clothing

The normal minimum protective clothing required for work in the laboratories and cell areas of Bldg. 3047 consists of the following: (a) safety glasses, (b) khaki clothing, lab coat, and (c) safety shoes. Such items as coveralls, gloves, caps, jackets, etc. are provided for wear as needed.

Clothing should fit properly. Loose clothing can get snagged on equipment, clothing legs that are too long can lead to falls, or clothing that is too tight can cause discomfort and loss of efficiency. Clothing marked "contamination" cannot be worn outside regulated zone areas except when traveling in a properly marked vehicle.

2. Gas Masks

Three types of gas masks are available for use in Bldg. 3047: (a) standard assault mask, (b) full-vision mask, and (c) air-supplied respirator. Gas masks are used in areas where airborne contamination or vapor hazards exist or can be expected to occur. These areas are designated by supervision as they occur, and a gas mask must be worn. Certain areas are permanent gas mask areas. Gas masks are used once and then sent for cleaning. They should be placed in plastic bags and delivered to the Health Physics office after use, not left lying around. Eye glasses cannot be worn with either the assault mask or the full-vision mask.

A supply of gas masks is kept on hand for normal use. The gas masks in the Emergency Cabinet are for emergency use. If it is necessary to use masks from these cabinets because of short supply, supervision should note this and replace the masks as soon as possible. The masks in the Emergency Cabinet are not to be removed without permission of the building supervisor, except in emergencies.

3. Air-Line Suit

The air-line suit is used for protection from contamination and for some chemical work. It consists of three sections: (a) air-line vest, (b) plastic top and helmet, and (c) plastic trousers. The vest is worn under the top and an air-line is connected to a quick-connect fitting on the vest. A headband with air-line attached fits around the forehead, and two air lines extend into the legs of the suit. Compressed air at 25 psi is supplied to the suit. A drawstring in the top part of the suit allows it to be tightened just below the waist, and air is exhausted at this point. Normally, not more than 50 ft of air line is used between the air supply and the suit; permission to use more must be obtained from building supervision.

When working in an air-line suit, an operator must be observed constantly. The observer gives assistance to the operator putting on or removing the suit and observes while the work is being done. He keeps the air line straight, provides tools and equipment, and must be ready to give emergency assistance if required.

Situations which require air-line suits include decontamination in cells, handling of large amounts of acid, and removal of contaminated equipment from cells.

Air-line suits are checked for damage when they are brought into the building. They should also be inspected by the observer before use.

No more than two air lines should be used at one station at the normal air pressure setting.

4. Face Shield

Plastic face shields are to be worn while pouring or mixing chemicals. These shields are not designed as protection from impact, but are to prevent harmful chemicals or particles from coming in contact with the face.

Face shields should be cleaned before and after use and should be kept off the work tables. Face shields lying around are likely to pick up harmful chemicals.

5. Safety Glasses

It is a building regulation that safety glasses or their equivalent be worn at all times by personnel working in the building.

There is a certain resistance on the part of some personnel to the wearing of safety glasses. Like all other items in this group, safety glasses are intended for the protection of the individual. Everyone should be aware of the obvious need for eye protection; however, if a person cannot accept logical explanations of this need, two statements cover the wearing of safety glasses:

a. Common sense suggests them, and
b. Regulations require them.

Failure to wear safety glasses is cause for disciplinary action. Any person who breaks, misplaces, contaminates, or otherwise renders his safety glasses unusable should report this immediately to supervision. Laboratory goggles may be worn while safety glasses are being replaced.

6. Hard Hat

At certain times areas in the building may be designated as "hard hat" zones. These areas are posted with appropriate signs, and wearing of hard hats is required at all times. Even temporary entry into a "hard hat" zone requires a hard hat. Hard hats are kept on hand as part of the building protective equipment.

7. Safety Shoes

Safety shoes are supplied to all personnel and should be worn while working in the building.

8. Safety Belt and Line

Safety belts and harnesses are used mostly for work at the top of a cell. When a worker is in a cell with a safety line, an observer is required. Also, the safety line must be secured at the top of the cell. For work on the top of a cell, the line must be secured with the minimum length of line which allows the necessary freedom of movement. If a safety belt is used with a plastic air-line suit, it should be worn under the suit so that the belt cannot restrict the air line.

A safety line should be of minimum length and in no case should it be long enough to allow a man to fall more than his own height. This rule-of-thumb is based more on the body's ability (or lack of it) to stand shock than on the strength of the safety belt or line.

"Sash cord" is not used for safety lines.

Summary: The use of safety equipment is the responsibility of each individual for his own protection. However, since the safety of all employees is of direct concern to supervision, the supervisor must make sure that the proper use of safety equipment is known and adhered to by all his personnel.

Handling and Storing of Chemicals and Equipment

1. All materials weighing over 50 lb will be handled by two or more men or by the crane. The weight limit is 50 lb per man.

2. Loading areas will be chained off when equipment or chemicals are being lifted with the crane.

3. Gas cylinders will be handled according to standard procedure and all empties will be tagged and placed in the EMPTY racks.

4. Carboys will be handled by carboy lifters and drum holders will be flushed and tagged after emptying.

5. Acid bottles will be carried in approved containers and all empties will be cleaned immediately after emptying.

6. All empty chemical containers shall be removed from the building and stored in proper places as soon as possible.

7. All solvents will be contained in approved vessels and stored inside approved solvent storage cabinets.

8. Safety showers, fire fighting equipment, aisles, and exits shall be kept clear of all materials.

9. Flammable material will not be stored under or above any stairwell.

Mechanical and Electrical Equipment

1. No mechanical equipment, i.e., cranes, pumps, agitators, etc. will be operated until the operator personally clears the immediate area of personnel.

2. Main electrical switches will be locked out and tagged whenever work is necessary on electrical equipment.

3. Danger tags will not be removed from equipment by anyone except the person who originally placed them on the equipment.

4. When not in use, the crane hook will always be left at least 7 ft above the floor or within a roped-off area.

Fire Fighting and Emergency Equipment

1. Cell personnel shall acquaint themselves with the operation and location of all fire fighting and other emergency equipment.

2. All personnel shall acquaint themselves with the operation and location of all safety showers.

3. All personnel shall acquaint themselves with the operation and location of assault masks and air-line suits.

Safety and Housekeeping

Since good housekeeping is conducive to safety, the building supervisor is responsible for keeping the building in an orderly fashion at all times.

The building supervisor, or his designated representative, shall tour the building each working day looking for possible hazards, equipment needing repair, or improvements that could be made.

OPERATING PROCEDURE
ALPHA LABORATORY - ROOM 211

This procedure describes the operation of the following Room 211 systems:

1. Containment
2. Heat sensor
3. Liquid level probe (glove box floor)
4. Glove box exhaust
5. Glove box atmosphere
6. Glove box standby
7. Bag in - Bag out
8. Glove or bag change
9. Emergency assistance switch

Containment

A recirculating air handling system provides filtered makeup air to Rooms 110, 211, and 212. Air is recirculated from Rooms 110 and 212 through a bank of four HEPA and four roughing filters from each room. Air from this system is routed to Room 211 but not recirculated from Room 211.

Exhaust air from Room 211 passes through a 20 × 16 × 2 in. FG-25 filter (ORNL Stores No. 07-642-7796) to the Isotopes Area Cell Ventilation System. The pressure drop across the filter is measured on a 0-4-in. water magnehelic gage mounted on the exhaust duct. The exhaust filter shall be changed when the pressure drop exceeds 3 in. water gage or when the room negative pressure drops below -0.3 in. water gage. A magnehelic gage to measure exhaust air flow is also mounted on the exhaust duct, and a chart is located on a nearby wall surface. A flow in excess of 1000 cfm should be maintained. A damper in the exhaust duct may be adjusted to maintain the required operating conditions.

Daily readings shall be recorded on the Room 211 Operating Checklist (see page 70).

A photohelic gage with adjustable set points measures the Room 211 pressure. When the room negative pressure drops from -0.3 in. water gage (normal operating pressure) to the low set point -0.15 in. water gage, an alarm is activated after a 10-sec delay. The delay permits personnel entrance and exit from the room without sounding the alarm. A by-pass switch inactivates the alarm when it is necessary to introduce or remove equipment from the room. An on-off switch for the recirculating air system is located in the same instrument panel.

The following settings should be maintained for normal operating conditions:

1. Power switch on
2. Selector switch to normal
3. Photohelic low set point at -0.15
4. Air recirculating system on

Heat Sensors

Each of the three process glove boxes in Room 211 is equipped with a heat sensor that is set to sound an alarm if the inside temperature reaches 140°F. The sensors are connected to the Bldg. 3047 dual alarm panels and may be heard in Rooms 109, 211, and the central stairwell. Each sensor is identified on a panel with lights, bell, and acknowledge button; and the panel is located on the west wall of Room 211.

A test of each unit shall be conducted quarterly with a heat source or by shorting the circuit at the detection unit. A record of each test shall be maintained on the current checklist for Room 211.

Liquid Level Probe

Each of the three process glove boxes in Room 211 is equipped with an electrical probe to detect a buildup of water in the boxes that may occur from a leak in the cooling water or process water systems. The probes are connected in parallel with the heat sensors; when an alarm is activated, a check must be made to determine which system is involved. A visual inspection inside the box or touching the outside surface of the box should give an immediate indication of the cause for an alarm.

A test of each probe unit shall be conducted quarterly with a wet wipe or towel. A record of each test shall be maintained on the current checklist for Room 211.

Glove Box Exhaust

Each of the three glove boxes in Room 211 is connected to the Isotopes Area hot off-gas system. The hot off-gas header is routed through Room 212 and is equipped with a control valve that is operated with a recorder-controller. A relief valve in the header limits the header negative pressure to -5 in. water gage. The control valve and relief valve are located on the west wall of Room 212.

The hot off-gas header in Room 211 is equipped with two 50-cfm testable HEPA filters in parallel.

Maxitrol valves control the exhaust from each of the three glove boxes and the access glove box to a negative pressure of -0.5 to 1.5 in. water gage with a normal purge flow of air or argon at approximately 1.0 cfm.

A photohelic controller with high and low set points turns off the normal purge flow if the glove box negative pressure passes the low set point (-0.5 in. water gage) and turns on a high purge flow (approximately 6 cfm) if the pressure increases past the high (-1.5 in. water gage) set point.

To prevent excessive positive or negative pressure in the glove boxes from sources other than the exhaust system, a Pyrex vessel is connected to each box to provide positive relief at 1 in. water gage positive pressure and 5 in. water gage negative pressure.

The following information shall be recorded on a daily checklist:

Off-gas header pressure (Room 212)
Off-gas controller setting (Room 212)
Glove box pressure (4 ea) (Room 211)
Photohelic set points (3 ea) (Room 211)
Purge gas (air or argon) flow
Transfer chamber pressure

Glove Box Atmosphere

The three process glove boxes are designed for air or argon atmosphere. Air or argon is selected manually and flows through the purge system mentioned in the glove box exhaust description. The air or argon flow passes through solonoid valves and rotameters for both low and high flow to each box. A photohelic unit with adjustable set points controls both the purge (low flow) and high flow to each glove box.

Readings for this system are recorded under the glove box exhaust listing.

The access glove box is an air atmosphere box and is not used for processing operations. The negative pressure is controlled with a Maxitrol valve to approximately 1 in. water gage. Inlet air to the box flows through a 50 in.^{2} filter with changeable cartridge.

Glove Box Standby

The following operations are to be performed when glove boxes are to be left unattended overnight, on weekends, or for indefinite periods of time:

1. Metal ports in process glove boxes shall have metal port bungs installed from inside each box. Plastic ports shall have metal covers installed from outside the box.

2. For periods of time exceeding five days, gloves hanging on the outside of the ports shall be enclosed in a plastic bag sealed to the glove port.

3. Gloves shall be monitored for radiation contamination by probe and/or smear before use after being unattended overnight, on weekends, or for indefinite periods of time.

4. Gloves shall be changed on a monthly basis in glove boxes known to contain high-level quantities of curium-244 contamination.

Record on Room 211 checklist standby time (date start and date end) and glove changes.

Bag Out - Bag In

The following operations shall be performed during the bagging out and bagging in of materials in the access glove box:

Bag Out

1. Place a piece of blotter paper on the floor.

2. Wear "C" zone clothing, shoe covers, rubber gloves, and a gas mask during the entire operation.

3. Place an alpha survey meter with an air filter attachment as near to the operation as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc. during and after the bagging operation.

4. All bag-out operations shall be a two-man job.

5. Examine bag carefully before bagging operation to be sure there are no leaks.

6. Place material in bag and work to bottom of bag. Arrange bag carefully on heat sealer to remove wrinkles. Close heat sealer jaws and apply heat. Sealed area should have a clear appearance when seal is effective. Carefully cut through center of seal to remove bagged material and leave a sealed bag on the port.

7. Place bagged material in a metal container for transport or temporary storage.

8. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Bag In

1. Items 1, 2, and 3 under Bag Out shall apply.

2. Except in unusual circumstances a bag-in operation may be performed by one man.

3. The preferred method of bagging material in a glove box is to place the material in the existing bag and install a new bag over the existing bag. Release existing bag to inside of box (see Bag Change procedure).

4. A plastic bag shall be taped under the port and opened enough to trap any radioactive particles that may be dropped during the bag change operation.

5. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Glove or Bag Change

The following procedure shall be followed during glove or bag changes in the Room 211 glove boxes:

1. Tape a plastic bag under the bag or glove port and open enough to trap any radioactive material that may be released during the change operation.

2. Place blotter paper on the floor under the port.

3. Wear "C" zone clothing, shoe covers, rubber gloves, and an assault mask during the change operation.

4. Place an alpha survey meter with an air filter attachment as near to the port location as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc. during and after the change operation.

5. The change operation should be done slowly and carefully.

6. Remove inner clamp. Be sure an "O" ring is installed in the front port groove. Remove back "O" ring and outer metal clamp.

7. Roll cuff of glove or bag toward front "O" ring.

8. Install new glove or bag and install back "O" ring and outer metal clamp.

9. Remove old glove or bag and front "O" ring to inside of box and install new front "O" ring and inner clamp.

10. Survey all materials involved in the change operation and clean if necessary to clear area for normal operation.

Emergency Assistance Switch

A switch is located on the bottom portion of the heat sensor panel on the west wall of Room 211. The switch is manually operated and is connected to the dual alarm panel in Room 109 and to an amber warning light at the entrance door to Room 211. In the event of a contamination incident or if assistance is required, the switch may be used to summon aid. Check switch once each week and record on checklist.

CHECKLIST
Building 3047 - Room 211

DATE _____

Containment

Exhaust Filter Pressure Drop - Inches Water _____
Exhaust Air Flow - cfm _____
Photohelic Alarm - Power Switch On _____
Photohelic Alarm - Selector Switch to Normal _____
Photohelic Alarm - Low set Point -0.15 in. Water _____
Photohelic Alarm - Air Recirculating System On _____

Heat Sensors

Test Quarterly

Box A _____
Box B _____
Box C _____

Liquid Level Probes

Test Quarterly

Box A _____
Box B _____
Box C _____

Glove Box Exhaust

Off-Gas Header Pressure (Room 212) _____
Off-Gas Controller Setting (Room 212) _____
Glove Box Pressure Box A (Room 211) _____
Glove Box Pressure Box B (Room 211) _____
Glove Box Pressure Box C (Room 211) _____
Glove Box Pressure Box Access (Room 211) _____
Photohelic Set Points Box A (Room 211) High _____ Low _____
Photohelic Set Points Box B (Room 211) High _____ Low _____
Photohelic Set Points Box C (Room 211) High _____ Low _____
Purge Gas (Air or Argon) Flow Box A _____ Box B _____ Box C _____
Transfer Chamber Pressure _____

Glove Box Standby

Box A	Start _____	End _____	Glove Changes _____
Box B	Start _____	End _____	Glove Changes _____
Box C	Start _____	End _____	Glove Changes _____
Box Access	Start _____	End _____	Glove Changes _____

Emergency Switch

Test _____

_____
Signature

OPERATING PROCEDURE
ROOM 212

Vacuum Furnaces

This procedure describes the operation of the three vacuum furnaces in Room 212.

1. Containment
2. Access Glove Box Exhaust System
3. Access Glove Box Atmosphere System
4. Heat Sensor
5. Furnace Vacuum Chamber
6. Bag Out - Bag In
7. Glove or Bag Change
8. Glove Box Standby
9. Furnace Operating Procedure
   a. TECO Furnace (south)
   b. Brew Model 424-C (center)
   c. Sanders Brew Model 466 (north)

Containment

A recirculating air handling system provides filtered make-up air to Rooms 110, 211, and 212. Air is recirculated from Rooms 110 and 212 through a bank of four HEPA and four roughing filters from each room. Air from this system is routed to Room 211 but is not recirculated from Room 211.

Exhaust air from Room 212 passes through a 24 × 24 × 2 in. FG-25 filter (ORNL Stores No. 07-642-7811) to the Isotopes Area Cell Ventilation System. The pressure drop across the filter is measured on a 0-4-in. water magnehelic gage mounted on the exhaust duct. The exhaust filter shall be changed when the pressure drop exceeds 3 in. water gage or when the room negative pressure drops below -0.3 in. water gage. A magnehelic gage to measure exhaust air flow is also mounted on the exhaust duct, and a chart is located on a nearby wall surface. A flow in excess of 1000 cfm should be maintained. A damper in the exhaust duct may be adjusted to maintain the required operating conditions.

Daily readings shall be recorded on the Room 212 Operating Checklist (see page 76).

A photohelic gage with adjustable set points measures the Room 212 pressure. When the room negative pressure drops from -0.3 in. water gage (normal operating pressure) to the low set point -0.15 in. water gage, an alarm is activated after a 10-sec delay. The delay permits personnel entrance and exit from the room without sounding the alarm. A by-pass switch inactivates the alarm when it is necessary to introduce or remove equipment from the room through the hatch or doorway. An on-off switch for the recirculating air system is located in the same instrument panel.

The following settings should be maintained for normal operating conditions:

1. Power switch on
2. Selector switch to normal
3. Photohelic low set point at -0.15
4. Air recirculating system on

Record settings on checklist.

Access Glove Box Exhaust System

The glove boxes are located above the furnace vacuum chambers and are equipped with filtered exhaust lines connected to the hot off-gas manifold on the west wall of Room 212. A control valve that is operated with a recorder-controller regulates the hot off-gas pressure, and a relief valve in the header limits the header negative pressure to -4.5 in. water gage.

Exhaust lines from each access glove box are controlled by Type 210-EZ Maxitrol valves set at -0.5 to 1.0 in. water gage. Each exhaust line contains access ports for DOP testing, and the filters are 50 cfm units (ORNL Stores 07-645-5012).

A Pyrex glass vessel is connected to each box through a line filter and is designed to relieve excessive pressure in the boxes at -5 in. and +1 in. water gage.

The pressure on each box shall be recorded on the daily checklist.

Access Glove Box Atmosphere System

Argon is introduced to the access glove boxes through line filters, and the flow is controlled by photohelic units with high- and low-flow set points. The set points control the flow-through solonoid valves and a flowmeter at a rate of ∿1 cfm normal flow. The Maxitrol control valves maintain a constant negative pressure in the enclosures.

Record flow and photohelic settings for each box on checklist.

Heat Sensor

A heat detector is mounted in the top of each access glove box and is connected to a local alarm and to the Bldg. 3047 alarm system in Room 109 and the central stairway.

The unit shall be tested quarterly and recorded on the checklist.

Furnace Vacuum Chamber

To prepare furnace chamber and glove box for loading operation, the following sequence shall be followed:

1. If argon atmosphere is required, pump chamber down to ∿150 microns and backfill with argon (use Starting Procedure for appropriate vacuum furnace).

2. Repeat Item No. 1.

3. Bag specimen into access glove box.

4. Purge glove box for 15 min with argon.

5. Open furnace chamber and place specimen inside. Specimen should rest firmly on hearth plate and have adequate clearance from the heating element. Reassemble furnace components and install vacuum cover. Be sure viewing port for optical pyrometer reading is clear.

Bag Out - Bag In

Bag Out

1. Place blotter paper on the floor.

2. Wear "C" zone clothing, shoe covers, rubber gloves, and a gas mask during the bagging operation.

3. Place an alpha survey meter with an air filter attachment as near to the operation as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc., during and after the bagging operation.

4. All bag-out operations shall be a two-man job.

5. Examine bag carefully before bagging operation to be sure there are no leaks.

6. Place material in bag and work carefully to bottom of bag. Remove as much trapped air from the bag as possible. Twist the bag tightly and tape a section approximately 6 in. long. Cut through the approximate center of the 6-in. taped section and tape a small plastic bag over each cut end.

7. Place bagged material in a metal container for transport or temporary storage.

8. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Bag In

1. Items 1, 2, and 3 under Bag Out shall apply.

2. Except in unusual circumstances a bag-in operation may be performed by one man.

3. The preferred method of bagging material in a glove box is to place the material in the existing bag and install a new bag over the existing bag. Release existing bag to inside of box (see Bag Change Procedure).

4. A plastic bag shall be taped under the port and opened enough to trap any radioactive particles that may be dropped during the bag change operation.

5. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Glove or Bag Change

The following procedure shall be followed during glove or bag changes:

1. Tape a plastic bag under the bag or glove port and open enough to trap any radioactive material that may be released during the change operation.

2. Place blotter paper on the floor under the port.

3. Wear "C" zone clothing, shoe covers, rubber gloves, and an assault mask during the change operation.

4. Place an alpha survey meter with an air filter attachment as near to the port location as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc. during and after the change operation.

5. The change operation should be done slowly and carefully.

6. Remove inner clamp. Be sure an "O" ring is installed in the front port groove. Remove back "O" ring and outer metal clamp.

7. Roll cuff of glove or bag toward front "O" ring.

8. Install new glove or bag and install back "O" ring and outer metal clamp.

9. Remove old glove or bag and front "O" ring to inside of box and install front "O" ring and inner clamp on new glove or bag.

10. Survey all materials involved in the change operation and clean if necessary to clear area for normal operation.

Glove Box Standby

The following operations are to be performed when glove boxes are to be left unattended overnight, weekends, and for indefinite periods of time:

1. Metal and plastic ports shall have metal covers installed from outside the box.

2. For periods of time exceeding five days, gloves hanging on the outside of the ports shall be enclosed in a plastic bag sealed to the glove port.

3. Gloves shall be monitored for radiation contamination by probe and/or smear before use after being unattended overnight, on weekends, or for indefinite periods of time.

4. Gloves shall be changed on a monthly basis in glove boxes known to contain high-level quantities of curium-244 contamination.

5. Record on Room 211 checklist standby time (date start and date end) and glove changes.

CHECKLIST
Building 3047 - Room 212

DATE _____

CONTAINMENT

Exhaust filter pressure drop - inches water _____
Exhaust air flow - cfm _____
Photohelic alarm - power switch ON _____
- selector switch to N _____
- low set point -0.15 in. H_2O _____
- air recirculating system ON _____

HEAT SENSORS AND EMERGENCY SWITCH

Test quarterly
TECO Furnace Box Pressure _____
424-C Brew Furnace _____
466 (Sanders) Brew Furnace _____

ACCESS BOX EXHAUST

Off-gas header pressure _____
Off-gas controller setting _____
TECO Furnace Box Pressure _____
424-C Brew Furnace _____
466 (Sanders) Brew Furnace _____
Photohelic Set Points (TECO) _____
(424-C) _____
(466) _____
Purge gas - on during transfers only _____

GLOVE CHANGE

TECO _____
424-C _____
466 _____

STANDBY

TECO _____
424-C _____
466 _____

_____
Signature

OPERATING PROCEDURE
ALPHA CUBICLE - ROOM 110

This procedure describes the operation of the following Room 110 systems:

1. Containment
2. Cubicle description
3. Cubicle exhaust system
4. Cubicle atmosphere system
5. Vacuum air lock
6. Access glove box
7. Heat sensors
8. Liquid level alarm
9. Bag In - Bag Out
10. Glove or bag change
11. Glove box standby
12. Emergency assistance switch

Containment

See Building Containment - System 1, page 11.

Recirculating Air System - See page 11.

Room 110 operates under continuous containment conditions (-0.3 in. water gage). A control panel is located on the south wall of Room 110 and is equipped with the following:

1. Panel on-off switch with indicator light
2. Start-stop switch for the recirculating fan
3. Three position switch - Normal, By pass, and Fan off
4. Photohelic gage with high and low set points
5. A 15-sec delay switch inside the panel to permit momentary drop during personnel entry and exit

Under normal operating conditions the panel should be set as follows:

1. Panel switch on.

2. Photohelic gage set at a low of -0.15 in. and a high of -0.4 in. (The black pointer should indicate ∿-0.3 in. - adjust cell ventilation damper in NW corner of room if necessary).

3. The three position switch should be on normal. (If the room pressure exceeds the low set point for longer than 15 sec, the recirculating fan will turn off and an alarm will sound.) Usual causes include low cell ventilation (plugged filter or fan failure) or open door to Room 110. Corrective measures must be taken immediately. Fan must be started manually. A planned entry of greater than 15 sec duration can be handled by turning the three position switch to by pass. CAUTION - Return switch to normal when entry is complete.

Cubicle Description

See Description of Manipulator Cubicle (Room 110), page 5 and Fig. A-5, Appendix A.

Cubicle Exhaust System

The cubicle exhaust system is routed to the Isotopes Area hot off-gas system through two sets of high-efficiency filters. Each set consists of dual filters (50 cfm) that will permit filter changing with the system on stream. Filters shall be changed when the pressure drop across the filters exceeds 3 in. water gage. One set of filters is located in the upper portion of the rear wall of the cubicle. The second set of filters is in the southwest corner of Room 110.

A Foxboro controller on the Cubicle Instrument Panel regulates a control valve in the cubicle exhaust system. The controller has an adjustable set point from 0 to -2 in. water gage and should be regulated to operate at approximately -1 in. water gage on the cell pressure gage on the instrument panel.

In addition to a relief valve in the hot off-gas system, a Pyrex vessel is connected to the cubicle to relieve the internal pressure at +1.0 in. water gage and -5 in. water gage.

Cubicle Atmosphere System

Valves to select the cubicle atmosphere (air or argon) are located inside the instrument panel.

An inlet gas flow throttling valve is located on the instrument panel to select the desired gas flow.

Automatic controls on the cubicle exhaust system interrupt the gas flow when the cubicle pressure drops below the set point. The flow resumes when the cubicle pressure returns to normal.

Vacuum Air Lock

Description

Materials may be introduced to the shielded cubicle through a vacuum air lock located in the south wall of the cubicle. Access to the air lock is through the access glove box. Identical closures for the air lock are operated with a ratchet wrench on the large nut on the threaded shaft.

Vacuum and atmosphere controls for the air lock are located on the north wall of the cubicle. After closing both access doors to the air lock, evacuate to approximately -20 in. Hg, close the vacuum valve, and observe vacuum gage for 2-4 min to check for leaks. When no leaks are detected, evacuate to >-29 in. Hg on gage, then turn off vacuum and introduce argon. Repeat 2 or 3 times if low oxygen content is desired. The air lock may also be vented to air. The line to the air lock and the vent line are equipped with high-efficiency line filters.

Operating Procedure

1. Close both air lock doors.

2. Turn on vacuum pump as follows:

   Open two valves from vacuum pump discharge to H.O.G.
   Open valve from vacuum pump to vacuum header
   Close valve from vacuum header to H.O.G.
   Turn on vacuum pump

3. Open vacuum valve (N side of cell) slowly to ∿-20 in. Hg on gage. Observe glass vessel connected to cubicle for change of pressure (reduced pressure indicates leak from air lock to cubicle).

4. Open vacuum valve to obtain maximum negative pressure (>-29 in. Hg). Close vacuum valve to pump. Observe gage 2 min for indication of leak.

5. Open argon header valve to vacuum transfer chamber and regulate flow meter to 20 scfh until gage pressure reads 0.

6. Close argon and repeat evacuation and argon addition 2-3 times.

Access Glove Box

The access glove box is located on the south side of the alpha cubicle and permits access to the cubicle through the vacuum air lock. The box is equipped with three upper level gloves and three lower level gloves and a 16-in. diameter bag port. The box is also equipped with a heat sensor and a valved drain to the cubicle hot drain line.

A water-filled shield tank to cover the vacuum air lock is located in the access glove box and is moved vertically with hydraulic cylinders. A safety stop is placed under the shield with the lower gloves when it is in the upper position. Caution must be exercised when the shield is raised to avoid applying excessive pressure to the stop. Flexible tubing is connected to the movable shield to permit filling and emptying from outside the access glove box.

Exhaust from the access glove box passes through a 50-cfm high efficiency testable filter to the cell ventilation system. Inlet air passes through a similar filter and a flow indicator measures the air flow through the box.

Movable Shield in Access Glove Box

A hydraulically operated shield tank filled with water is located in the access glove box on the south side of the cubicle. Flexible plastic lines are attached to the tank through valves to permit filling and emptying from outside the access glove box. Before the shield is raised, a visual examination must be made of the following:

1. Flexible lines must be free of obstructions
2. Air lock door must be closed and ratchet wrench clear of shield tank
3. Remove all materials from top of shield tank
4. Bag and gloves must be free of top of shield tank
5. Check tank water level (tygon tube - west end of access glove box)

Shield tank may be raised or lowered as follows:

To Raise

1. Set hydraulic pump valve to down position
2. Turn pump on
3. Turn valve slowly to up position - observe shield tank movement and regulate valve for slow steady rise
4. When tank rises above the movable support, turn valve halfway between up and down to stop movement

CAUTION DO NOT RAISE SHIELD TANK TO LIMIT OF HYDRAULIC RAMS

5. Using lower glove, place support against stop under the shield tank. The stop will hold the tank in the up position.
6. Turn off vacuum pump

To Lower

1. Turn on hydraulic pump
2. Raise shield tank slightly to clear support
3. Using lower glove, move support from underneath the shield tank
4. Move pump valve to down position. Tank will go down to the rest position
5. Turn off pump
6. Examine water lines to tank for leaks

Heat Sensors

The alpha cubicle and access glove box are equipped with heat sensors set to alarm at 140°F. The alarm sounds in Room 110 and is also connected to the Bldg. 3047 alarm system.

Each heat sensor shall be tested quarterly with a heat source or by short-circuiting the contacts outside the cubicle or glove box.

Liquid Level Alarm

A low-voltage probe is installed approximately 1 in. above the floor of the alpha cubicle to sound an alarm in the event of water leaking into the cubicle. The alarm is connected to the heat sensor alarm system to sound in Room 110 and through the Bldg. 3047 alarm system.

Bag Out - Bag In

The following operations shall be performed during the bagging out and bagging in of materials in the access glove box:

Bag Out

1. Place a piece of blotter paper on the floor.

2. Wear "C" zone clothing, shoe covers, rubber gloves, and a gas mask during the entire operation.

3. Place an alpha survey meter with an air filter attachment as near to the operation as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc. during and after the bagging operation.

4. All bag-out operations shall be a two-man job.

5. Examine bag carefully before bagging operation to be sure there are no leaks.

6. Place material in bag and work to bottom of bag. Arrange bag carefully on heat sealer to remove wrinkles. Close heat sealer jaws and apply heat. Sealed area should have a clear appearance when seal is effective. Carefully cut through center of seal to remove bagged material and leave a sealed bag on the port.

7. Place bagged material in a metal container for transport or temporary storage.

8. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Bag In

1. Items 1, 2, and 3 under Bag Out shall apply.

2. Except in unusual circumstances a bag-in operation may be performed by one man.

3. The preferred method of bagging material in a glove box is to place the material in the existing bag and install a new bag over the existing bag. Release existing bag to inside of box (see Bag Change procedure).

4. A plastic bag shall be taped under the port and opened enough to trap any radioactive particles that may be dropped during the bag change operation.

5. Survey all materials involved in the bagging operation and clean if necessary to clear area for normal operation.

Glove or Bag Change

The following procedure shall be followed during glove or bag changes in the Room 110 facility:

1. Tape a plastic bag under the bag or glove port and open enough to trap any radioactive material that may be released during the change operation.

2. Place blotter paper on the floor under the port.

3. Wear "C" zone clothing, shoe covers, rubber gloves, and an assault mask during the change operation.

4. Place an alpha survey meter with an air filter attachment as near to the port location as possible. This instrument will detect airborne particles and will provide a survey meter to check hands, clothing, etc. during and after the change operation.

5. The change operation should be done slowly and carefully.

6. Remove inner clamp. Be sure an "O" ring is installed in the front port groove.

7. Place new bag or glove inside old one and install inner clamp.

8. Remove back "O" ring and outer metal clamp.

9. Roll cuff of old glove or bag over front "O" ring to provide space for the new glove to bag on the port. Check for contamination.

10. Install new glove or bag on port. Install back "O" ring and outer metal clamp.

11. Remove inner clamp and remove old glove or bag inside of box. Reinstall inner clamp and outer "O" ring.

12. Survey all materials involved in the change operation and clean if necessary to clear area for normal operation.

Glove Box Standby

The following operations are to be performed when glove boxes are to be left unattended overnight, on weekends, or for indefinite periods of time:

1. Metal ports in process glove boxes shall have metal port bungs installed from inside each box. Plastic ports shall have metal covers installed from outside the box.

2. For periods of time exceeding five days, gloves hanging on the outside of the ports shall be enclosed in a plastic bag sealed to the glove port.

3. Gloves shall be monitored for radiation contamination by probe and/or smear before use after being unattended overnight, on weekends, or for indefinite periods of time.

4. Gloves shall be changed on a monthly basis in glove boxes known to contain high-level quantities of curium-244 contamination.

Record on Room 110 checklist (see page 84) standby time (date start and date end) and glove changes.

Emergency Assistance Switch

A switch is located on the bottom portion of the heat sensor panel on the north wall of Room 110. The switch is manually operated and is connected to the dual alarm panel in Room 109 and to an amber warning light above the entrance door to Room 110. In the event of a contamination incident or if assistance is required, the switch may be used to summon aid. Check switch once each week and record on checklist.

CHECKLIST
Building 3047 - Room 110

DATE _____

CONTAINMENT

Exhaust filter pressure drop _____
Exhaust air flow - cfm _____
Photohelic alarm - power switch ON _____
- selector switch to N _____
- low set point -0.15 in. H_2O _____
- air recirculating system ON _____

HEAT SENSORS

Test quarterly Cubicle _____ Access Box _____

LIQUID LEVEL PROBES

Test quarterly Cubicle _____ Access Box _____

CUBICLE EXHAUST

Off-gas header pressure _____
Off-gas controller setting _____
Cubicle pressure _____
Cubicle pressure relief vessel _____
Purge gas (air or argon) flow _____
Transfer chamber pressure _____
Pressure drop across filters _____

GLOVE BOX EXHAUST

Glove box pressure _____
Glove box air flow _____
Pressure drop across filters _____

GLOVE BOX STATUS

Operating _____
Standby _____

_____
Signature

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

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ORNL
CENTRAL FILES NUMBER

73 - 8 - 40*

DATE: August 29, 1973

SUBJECT: ISOTOPES DIVISION SOLID WASTE HANDLING PROCEDURE

TO: Isotopes Division Personnel

FROM: J. H. Gillette

FOREWORD

This procedure presents standard techniques for the safe handling of waste generated in the Isotopes Division. All members of the Division should become well acquainted with this procedure to eliminate unusual difficulties and incidents.

*Minor revisions made for this Hazards Report.

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ISOTOPES DIVISION SOLID WASTE HANDLING PROCEDURE

INTRODUCTION

Solid radioactive waste from the Isotopes Division may consist of contaminated bottles, swabs, paper, glassware, laboratory equipment, or any other solid materials used within hot cells, hoods, or glove boxes. These materials may be contaminated with alpha, beta, and gamma activities with beta-gamma radiation readings from 1 mR/hr to >10 R/hr at the surface of the primary package. No liquids are to be intermixed with solid waste but should be channeled through the appropriate liquid disposal system. This procedure is established to assure the safe handling and disposal of these materials and supplement procedure number 5.1 in the ORNL Procedures and Practices for Radiation Protection, Health Physics Manual.

DEFINITIONS

Low-Level Waste — Those materials which read <1 mR/hr beta-gamma at the surface of the primary package.

Intermediate-Level Waste — Those materials which read from 1 mR/hr to 200 mR/hr beta-gamma at the surface of the primary package.

High-Level Waste — All alpha or pure beta contaminated material.

All process equipment and other highly contaminated material from hot cells, shielded barricades, or glove boxes.

All material with a radiation reading >200 mR/hr.

All high-level beta-gamma wastes are to be transported to FPDL for proper packaging and disposal.

LOW-LEVEL WASTE HANDLING PROCEDURE (<1 mR/hr)

Containers

Each building in the Isotopes Division which handles radioactive materials will be supplied with disposal cans (Fig. 1) properly labeled for contaminated materials. The disposal can will be supplied with a double layer of plastic bags to guard against possible rupture of the plastic by sharp objects or poor seals formed on the seams (seals should be examined). Low-level waste may be disposed of in these containers.

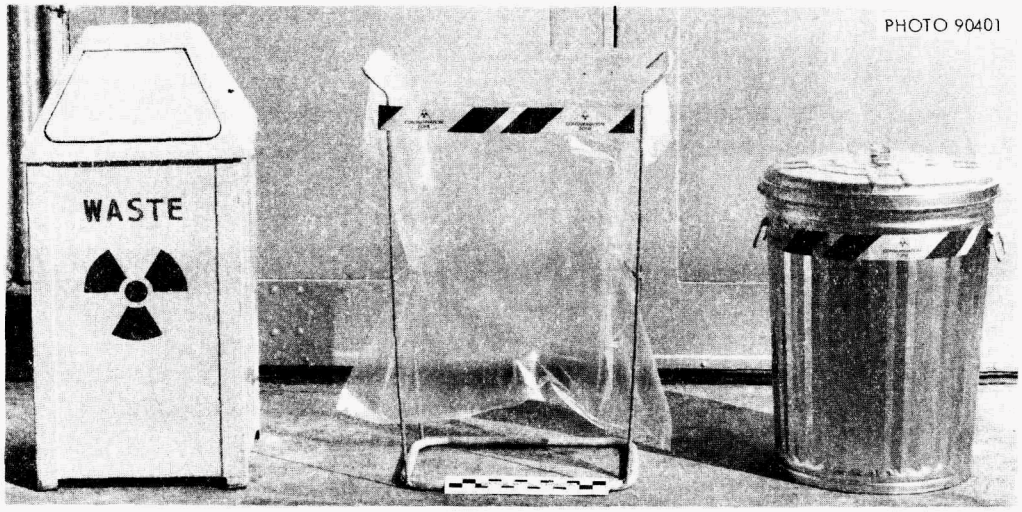

Fig. 1. Contaminated Waste Disposal Containers.

Procedure for Disposal Units Within Defined Limits

When the disposal unit is filled, the chemical operator or technician responsible for waste removal will carefully seal the plastic bag with tape or a heat-sealing device. The sealed package is to be properly tagged with a radiation reading and the individual's name. All plastic bags containing low-level material will be placed in an appropriate container and delivered, by assigned personnel, to the nearest yellow Dumpster (Fig. 2) for removal to the burial ground. Clean plastic bags will be installed by the user in all disposal cans and Health Physics personnel will check all cans once per day for radiation and contamination levels above those approved by the Health Physics Manual.

Procedure for Disposal Units Exceeding Defined Limits

If a container reads >1 mR/hr, see procedure for handling intermediate- or high-level waste.

Contamination waste-disposal cans are not to be used for high-level waste materials. Any disposal can reading >200 mR/hr will be reported immediately to supervision and handled as high-level waste.

Procedure for Washable Items

Gloves, shoe covers, etc., will be handled under the same rules that apply to low-level waste except that all washable items reading <20 mR/hr beta-gamma and 25,000 dis/min alpha will be sent to the laundry. All materials above these levels of contamination must go to the burial ground as waste. Disposal cans appropriately labeled for gloves, shoe covers, etc., will be available for those buildings requiring laundry service.

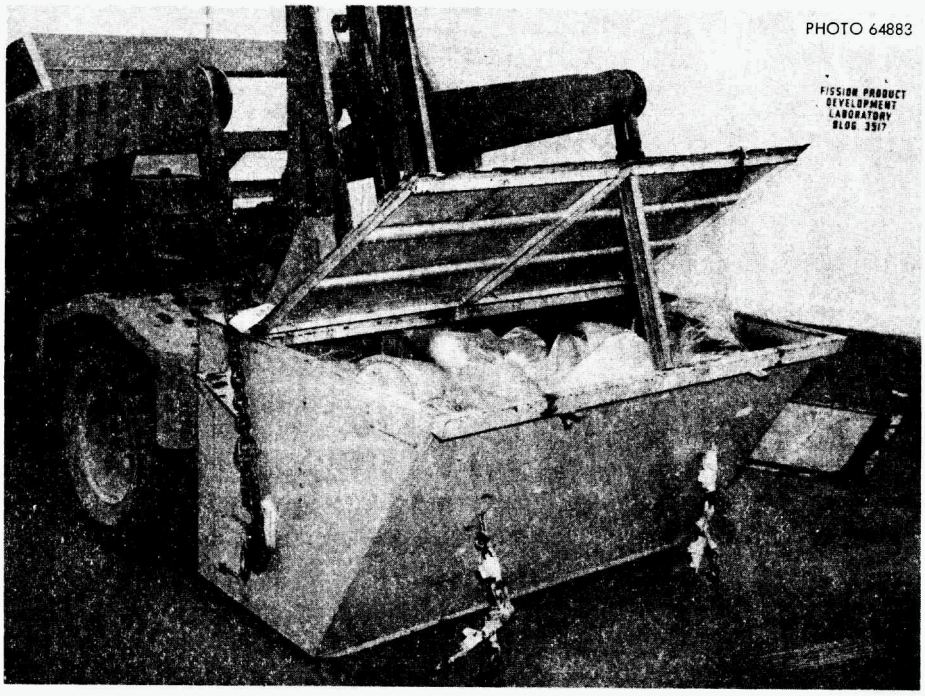

Fig. 2. Yellow Dumpster for Low- and Intermediate-Level Solid Waste Disposal.

INTERMEDIATE-LEVEL WASTE HANDLING PROCEDURE (1 to 200 mR/hr)

Containers

Materials in the intermediate level of contamination must be handled very carefully to prevent the spread of contamination during all handling operations from the originating area to the burial ground. Materials in this range should be placed in cans or boxes purchased from Stores. Inexpensive cans (Fig. 3) are available in 1-, 2-, 10-, and 20-gal capacities at Building 3036. These may be used as primary and/or secondary containment shells for contaminated waste.

Procedure for Disposal Units Within Defined Limits

After the can is full and the lid sealed, the can should be smeared. If it does not smear more than 1 mR/hr, the can may be placed in a plastic bag, sealed, and transported to the yellow Dumpster. If the can smears >1 mR/hr, it must be placed in another solid container and sealed. The surface of the outer container must be smear clean in order to control the spread of contamination at the burial ground.

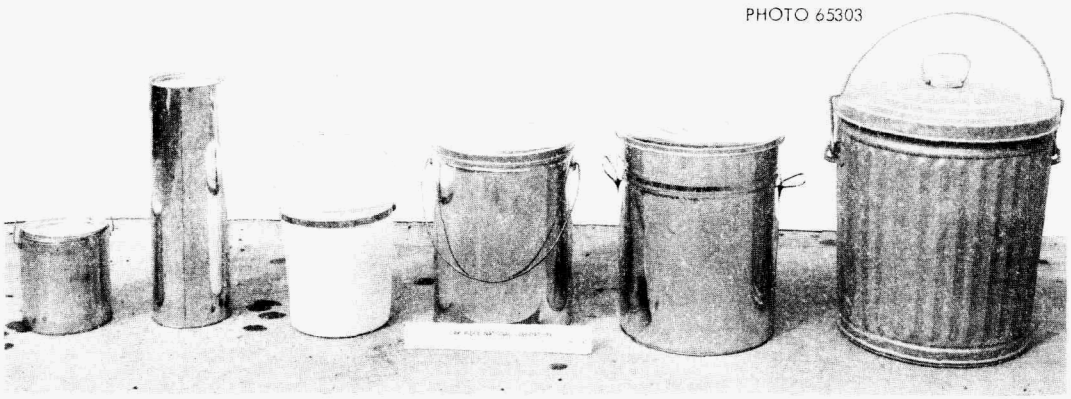

Fig. 3. Waste Disposal Cans.

Procedure for Disposal Units Exceeding Defined Limits

Contaminated waste above the specified limits should be removed from the building as soon as possible to reduce the exposure to personnel. If a can is above the specified limits, it should be placed in a garbage can, which is then sealed and tagged. A special hot truck should be requested to remove the package.

HIGH-LEVEL WASTE HANDLING PROCEDURE

(>200 mR/hr, all alpha and pure beta wastes)

Containers

High-level waste originating from hot cell or glove box operations in the Isotopes Division must be handled with extreme care to prevent exposure to personnel and the spread of high-level contamination within the Laboratory. Table 1 lists the containers used for transporting these materials to FPDL for disposal by the Isotopes Division and the characteristics of these containers.

Procedure

To remove high-level waste from a hot cell, barricade, or glove box, the radioactive material should be reduced to the smallest size possible and segregated into combustibles and noncombustibles. The material is then loaded into a suitable lard can, garbage can, or plastic pail to form the initial containment layer. The container should be sealed in plastic and transferred to one of the carriers previously listed. If a shielded

Table 1. High-Level Waste Carrier Data

Type	Cavity Volume (gal)	Shielding (in. of lead)	Weight (lb)	Normal Building Location	Figure No.
FPDL Bottom Discharge	1.0	4	1,000	FPDL	4
RDL Bottom Discharge	1.0	4	1,500	3047	5
Cobalt Garden	0.1	8	1,800	3029	6
Iodine-131 Ring	0.1	9	3,600	3028	7
SRO	2.0	3.5	2,000	3047 3036	8
Lead Dumpster	100	1	7,500	Burial Ground	9
Stainless Steel Dumpster	20	4	8,500	Burial Ground	10
Schaich Waste Carrier	5	6	5,000	FPDL	11
Cobalt Transfer	0.1	8	3,300	3029	12
Pierce Waste Carrier	11	8	10,000	3047	13
FPDL Top Loader	2.0	4	2,000	FPDL	14
SLFP Carrier	1.0	4	1,500	SLFP	15

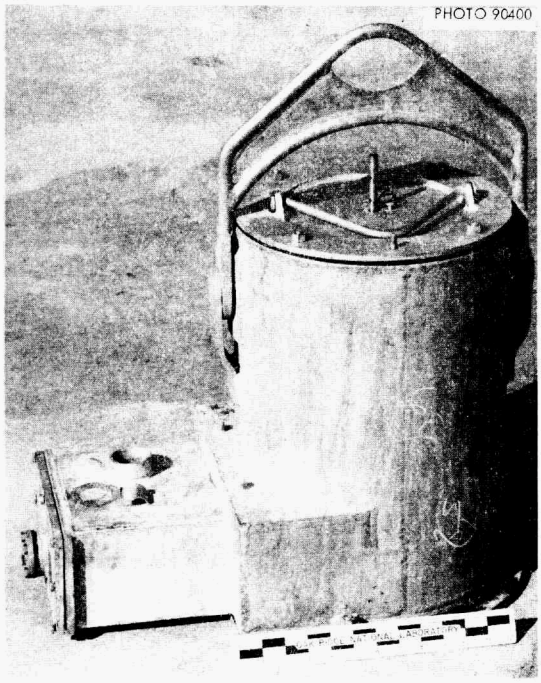

Fig. 4. FPDL Bottom Discharge Waste Carrier.

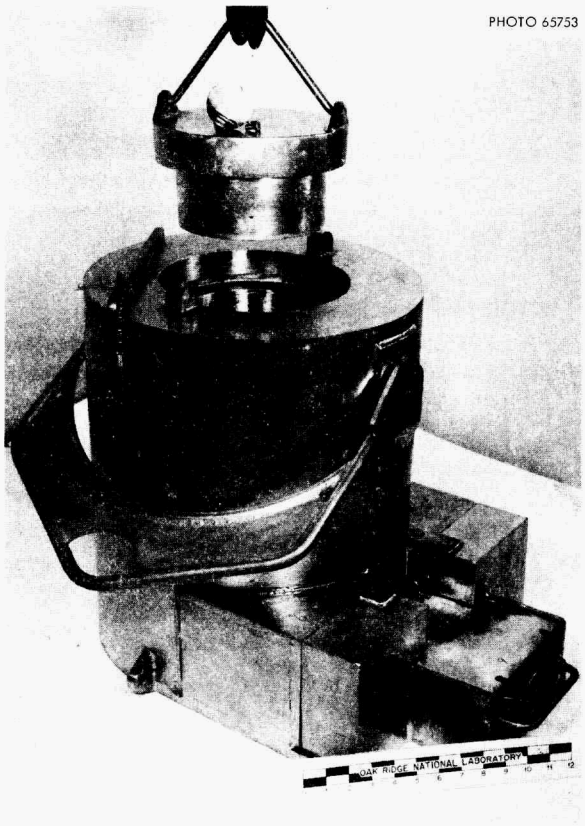

Fig. 5. RDL Bottom Discharge Waste Carrier.

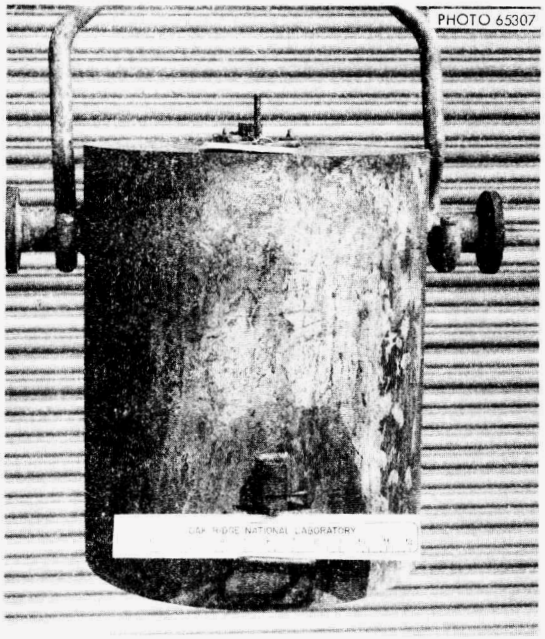

Fig. 6. Cobalt-Garden Transfer Carrier.

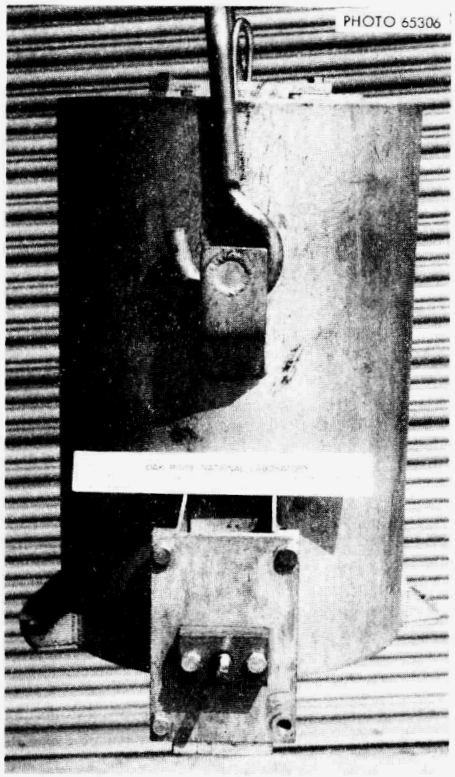

Fig. 7. Iodine-131 Ring Carrier.

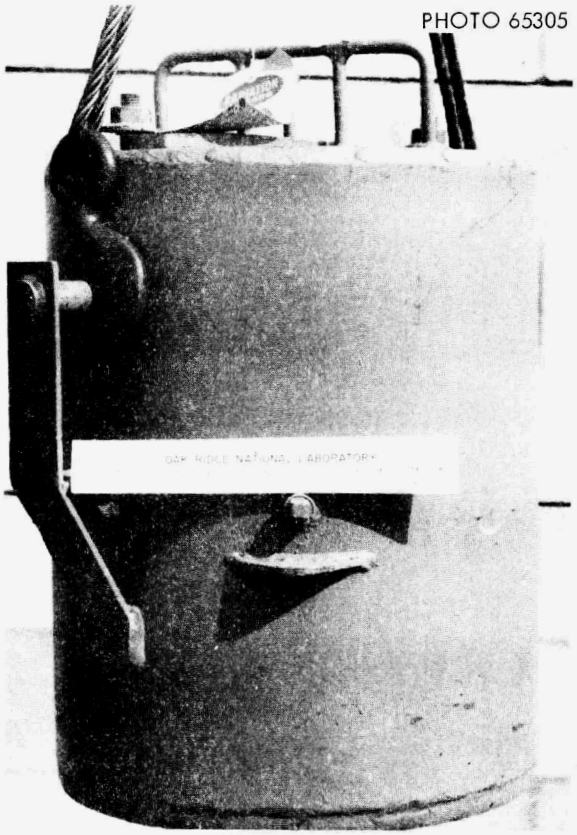

Fig. 8. SRO Carrier.

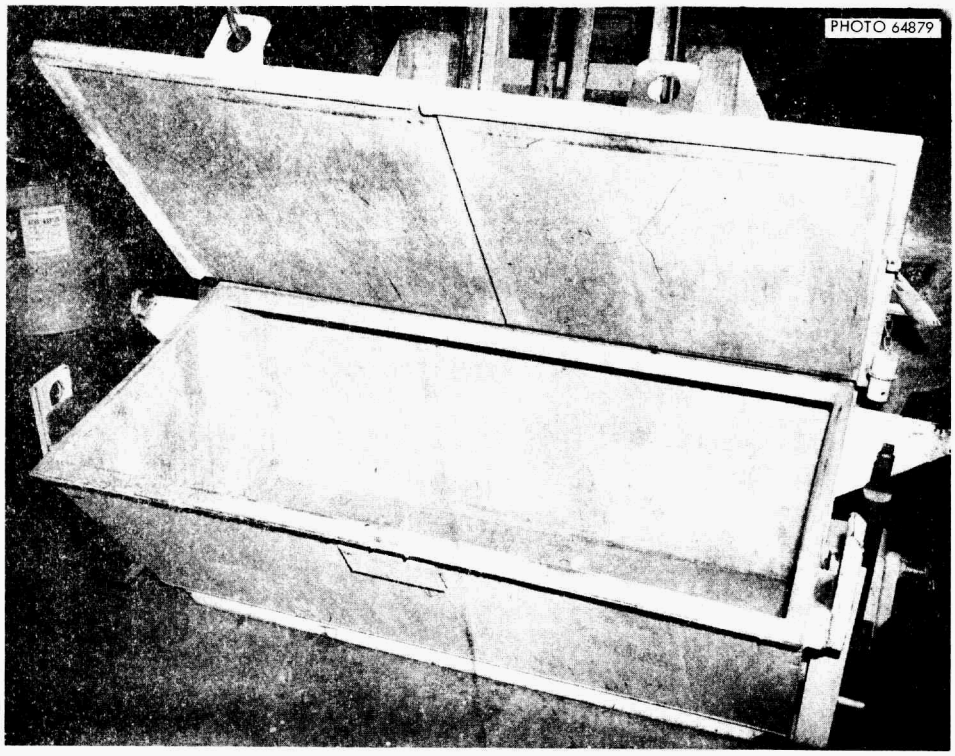

Fig. 9. One-Inch Lead Dumpster.

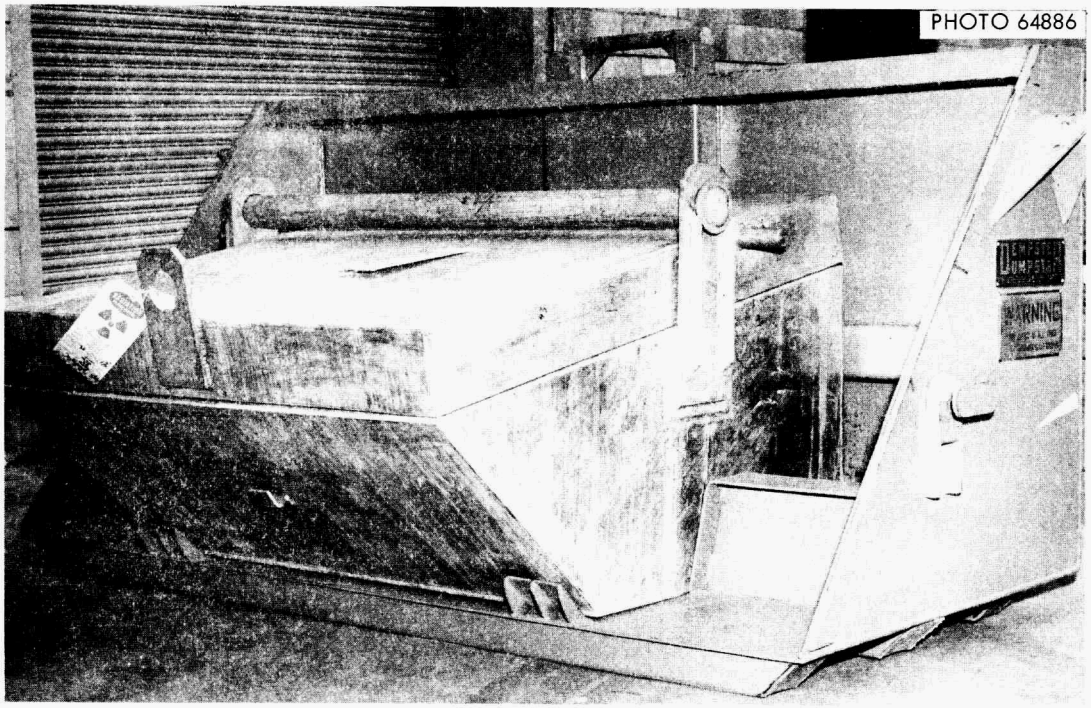

Fig. 10. Stainless Steel Dumpster.

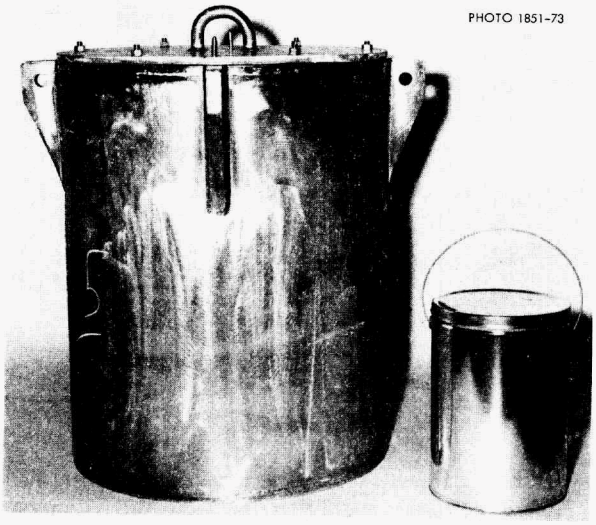

Fig. 11. Schaich Waste Carrier.

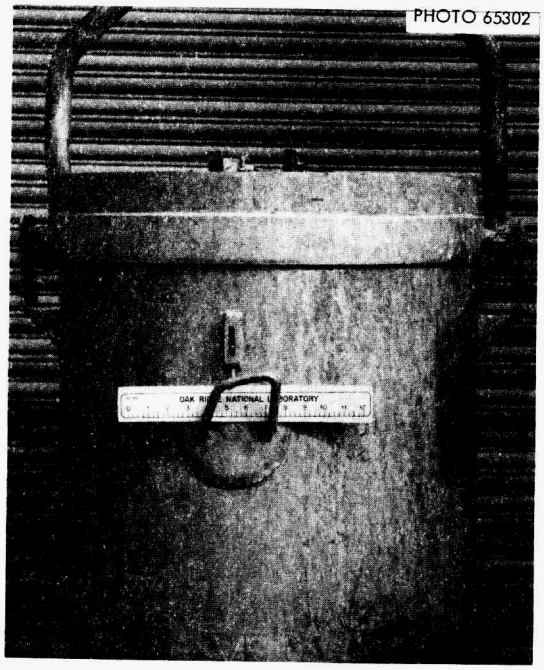

Fig. 12. Cobalt Transfer Carrier.

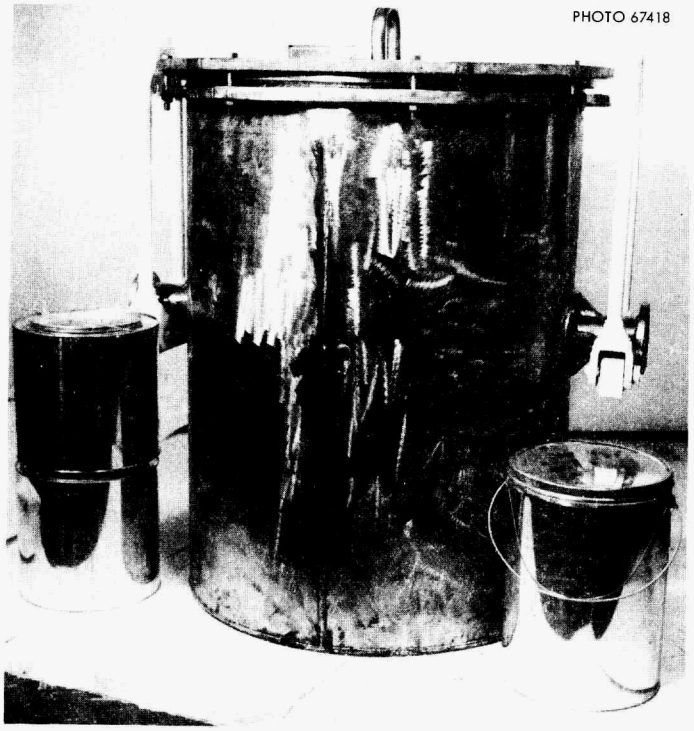

Fig. 13. Pierce Waste Carrier.

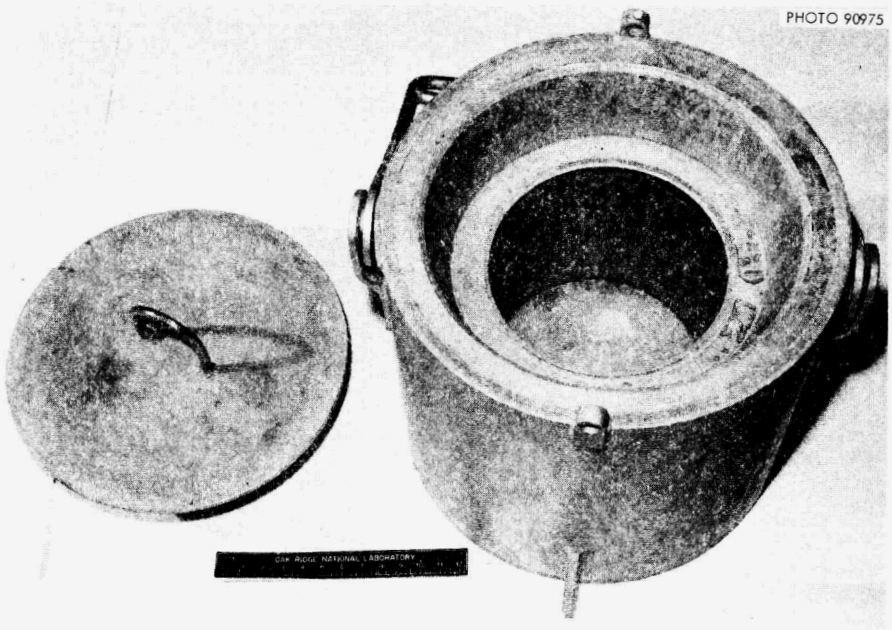

Fig. 14. FPDL Top Loader.

Dumpster is used (Figs. 9 and 10), it should be placed in the cell or immediately adjacent to the cell for loading with manipulators or long tongs. After the Dumpster is loaded and cleaned to shipping tolerances, it should be tagged and immediately removed from the area.

Bottom discharge carriers cannot handle cans sealed in plastic bags. Thus, waste materials should be bagged in plastic and placed in a can or plastic pail; the can or pail should be sealed and finally washed free of all loose contamination before being loaded into the carrier. This procedure will reduce the possibility of contamination at the FPDL or burial ground and aid in the decontamination of the waste carrier.

Material placed in lead-shielded Dumpsters must smear less than 10 mR/hr on the outer surface of the package, and the burial ground personnel must be notified as to its contents.

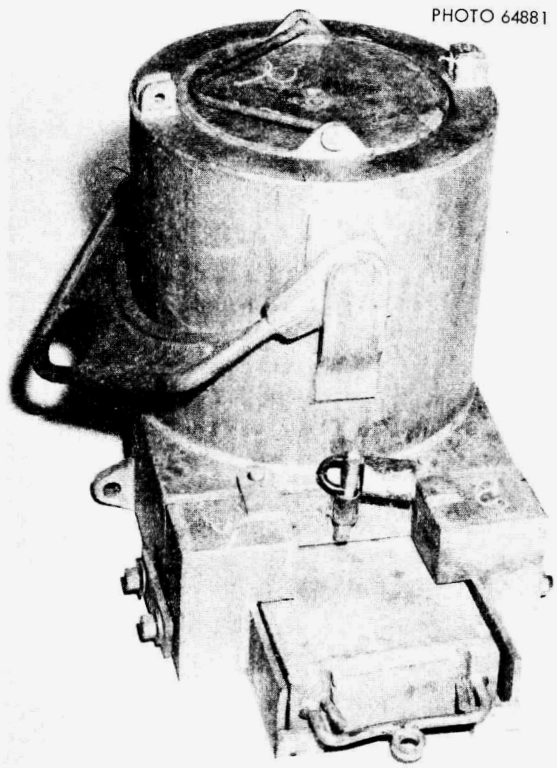

Fig. 15. SLFP Carrier.

High-level waste material should not be removed from a cell until a proper shielding device is ready to receive the package. Garbage cans with improvised shielding may be used with the supervisor's approval, provided prior arrangements for removal have been made with burial ground personnel. The burial ground supervisor will determine if the hot truck or a shielded Dumpster is required for removing the cans.

Additional Precautions for Handling High-Level Wastes

1. Wash and drain all equipment before removal.

2. Place all glassware and sharp objects in lard cans or garbage cans. This should apply to all levels of waste.

3. All radioactivity used for heat sources should be segregated from all burnable materials and placed in suitable steel containers for immediate disposal.

4. All alpha materials should be triply contained. If heat is no problem, the recommended procedure is a tin can sealed in plastic and then sealed in a cardboard shipping container.

5. When containers present a hazard from external radiation and cannot be immediately removed from the area, a radiation zone shall be established following the guidelines shown in Table 2.

Table 2. Guide for Establishment of Radiation Zones

Dose-Rate Range (rem/hr)	Immediate Action	Follow-up Action
0.003-0.006	Post low-level tags if the accumulated daily dose to personnel may be 20 mrem	Periodic review
0.006-1	Post warning signs or tags	Rope off the area if the accumulated weekly dose may be 1 rem
1-3	Post warning signs or tags; rope off	Erect a barricade which provides absolute exclusion of personnel. If the accumulated weekly dose in the area may be 12 rem, lock or block entrance
>3	Post warning signs and tags; erect barricades; lock and/or block all entries	

6. Transuranic solid wastes from the Isotopes Division are to be handled as high-level wastes and segregated into Class A or B per Health Physics Procedure Manual No. A9. This procedure is as follows.

INTERIM PROCEDURE FOR STORAGE OF TRANSURANIUM SOLID WASTE

1. Solid waste originating in operating areas where transuranium elements are handled shall be segregated into Class A and Class B.

   Class A

   a. Waste originating in areas where the alpha surface contamination does not exceed the following values:

      Direct Reading — 300 dis/min·100 cm^2 (average)
      3000 dis/min·100 cm^2 (maximum)

      Transferable — 30 dis/min·100 cm^2 (average)
      300 dis/min·100 cm^2 (maximum)

   b. Waste, regardless of origin, which does not exceed 10 $\mu Ci/ft^3$.

   Class B

   Waste which exceeds the above surface contamination values and/or activity concentration.

2. Class A waste shall be deposited in yellow Dumpsters for burial in the conventional manner.

3. Normally, when radiation levels at the surface of the containers will permit, Class B waste shall be deposited in one of the four types of containers listed below:

   a. 30-gal drums (stainless or coated steel) (Fig. 16).

   b. 55-gal drums (stainless or coated steel) (Fig. 16).

Fig. 16. 55- and 30-gal Drums.

c. Concrete cask (thin wall)

Outside dimensions — 51-in. OD by 7 ft
Inside dimensions — 42-in. ID by 6 ft 1 in.

d. Concrete cask (thick wall)

Outside dimensions — 51-in. OD by 7 ft
Inside dimensions — 27-in. ID by 4 ft 10 in.

The above containers may be obtained from Solid Waste Storage, telephone 3-6356.

In those cases when the above containers do not provide adequate shielding for the radioactivity to be transported and/or stored, other containers may be used subject to the approval of Solid Waste Storage personnel.

The four specified containers, when filled, will be stored in a roofed and drained trench. A minimum of rock back-fill will be used. Those containers holding high radiation level waste will be deposited in shielded, water-tight auger holes.

4. If at all feasible, burnable and nonburnable waste should be deposited in separate containers. Containers must be labeled as follows: B (burnable), NB (nonburnable), or BNB (mixture of burnable and nonburnable). Cost distribution for handling and storing solid waste will be based on the number and type of containers used.

5. Storage records shall be maintained. In addition to the requirements of Health Physics Procedure 4.1, the receivers shall apply a permanent tag to each container, radiation level permitting, which is referenced to a computer log. Where the radiation level is too great, the storage location (auger hole, etc.) shall be referenced.

6. The amount of fissile material permitted in the containers in item 3 is the following:

a. 30-gal drum — 20 grams

b. 55-gal drum — 36 grams

c. Concrete cask (thin wall) — 200 grams

d. Concrete cask (thick wall) — 96 grams

FROM ORNL TM 946 (REV 2)
" 3047 Haz Rep. "

Appendix D

CALCULATION METHODS

Maximum Downwind Dose

Radioactive material that may become dispersed in the air of a cell in Bldg. 3047 is carried through underground duct work to the Isotopes Area Filter Pit and then to the Bldg. 3039 stack where the air is discharged to the atmosphere at a height of 200 ft. All of the dispersible inventory in a cell will not reach the filters because some particles will be too large to remain entrained in the air stream and many others will be removed by impingement against the walls of the cell and ducts. For the purpose of these calculations, it is assumed that 20% of the dispersible inventory in the cell reaches the filter pit and that the particle size distribution and filter efficiency are as follows:[1]

Particle Size Range (μm)	Percent of Total Weight	Filter Removal Efficiency (%)
≥0.3	98.9	99.95
0.1–0.3	1.1	95.0
<0.1	0.1	87.0

If it is assumed that the radioactive material which penetrates the filters passes out the stack in a short period of time, the maximum dose will occur at the point where the plume hits the ground and will depend on the dilution of the plume as it expands upon leaving the stack. The extent of the dilution will vary according to the height of the stack, wind velocity, and atmospheric conditions and is evaluated for a specific set of conditions as follows:[2]

$$k_{ma} = 2/(\pi e \mu h^2),$$

$$k_{ma} = 1.6 \times 10^{-5} \text{ sec/m}^3.$$

where

k_{ma} = maximum average stack dilution factor, sec/m^3,

μ = wind velocity, m/sec,

h = effective stack height, m.

and for the Bldg. 3039 stack (250 ft) at a wind velocity of 3 mph, $k_{ma} = 1.6 \times 10^{-5}$ sec/m^3.

A value of 3 mph has been chosen as the wind velocity because k, which describes the maximum average ground concentration, goes through a maximum at about this value due to the dependence of the effective stack height on wind velocity as follows:[2]

$$h = H + d(V_s/\mu)^{1.4}\ (1 + \Delta T/T_s),$$

where

H = actual stack height, m,

d = stack diameter, m,

V_s = velocity in stack, m/sec,

T_s = stack gas temperature, °C,

ΔT = difference between stack and ambient temperatures.

The maximum dose received downwind for a given set of atmospheric conditions (k) can then be written:

$$D = \frac{(C)(k)(0.1)(1.44)}{(1.44 \times 10^5)(MPCa_{40})}\ \text{rem},$$

where

C = activity released from the stack, Ci,

k = stack dilution factor, sec/m^3,

$MPCa_{40}$ = maximum permissible concentration of radioactive material in air that will give a 100-mrem dose in 40 hr of exposure, Ci/m^3,

1.44×10^5 = seconds in 40 hr,

1.44 = factor to compensate for increased breathing rate.

The curies (C) of activity released from the stack can be obtained from the particle size distribution and filter efficiency as follows:

$$C = (Q_D)(0.2)[(0.988)(5 \times 10^{-4}) + (0.011)(0.05) + (1 \times 10^{-3})(0.13)],$$

where

Q_D = dispersible inventory in cell, Ci.

Therefore the maximum downwind dose for a particular isotope may be written as:

$$D = \frac{(Q_n)(1.6 \times 10^{-5})(10^{-6})(2.35 \times 10^{-4})}{MPCa_{40}} \text{ rem.}$$

Downwind Dose Distribution

It is assumed that the particles discharged from the stack are small enough to behave essentially like a gas, and the dilution of the plume at any distance from the stack will depend on the wind velocity, atmospheric diffusion coefficient, and atmospheric stability conditions. The stack dilution factor at any distance, X, from the stack is:[3]

$$k = \frac{2}{\pi C_x^2 X^{2-n} \mu} \; e^{-(h^2/C_x^2 X^{2-n})},$$

where

k = stack dilution factor, sec/m^3,

μ = wind velocity, m/sec,

h = effective stack height, m,

X = horizontal downwind distance from stack, m,

C_x = atmospheric diffusion coefficient,

n = atmospheric stability parameter.

For the neutral atmospheric conditions assumed in this report, the values of C and n are 0.1 and 0.25, respectively.

The time required for the plume to reach the ground (the maximum average ground level dilution) is:[4]

$$t = \frac{1}{\mu}(h^2/C_x^2)^{1/(2-n)}.$$

Therefore the horizontal distance from the stack at which the maximum ground level dose is incurred is:

$$X_{ma} = t\mu = (h^2/C_x^2)^{1/(2-n)}.$$

Maximum Contaminated Area

The maximum area enclosed by a specified contamination isopleth resulting from the plume of a stack release can be approximated by:[5]

$$A_{max} = 0.18/(w/c),$$

where

A_{max} = maximum contaminated area, m^2,

w = contamination level, Ci/m^2,

c = curies released from stack.

If an area is considered contaminated, it exceeds 30 dis/min·dm^2 alpha or 1000 dis/min·dm^2 beta-gamma, then

$$A_{\alpha} = (1.53 \times 10^3)c/30 \text{ mile}^2,$$

and

$$A_{\beta\gamma} = 1.53c \text{ mile}^2.$$

Dose to Containment Zone Personnel

The volume of air which will flow from the primary containment to the secondary containment if the primary containment volume becomes pressurized depends on the duration of the pressurization, the pressure differential between primary and secondary containment volumes during pressurization, and the leak rate of the primary containment barrier.

The dose received by personnel in the containment zone at the time of an accidental release of air-borne radioactive material from a cell will depend on the type and quantity of radioactive material released, the extent to which the activity mixes with the air in the secondary containment volume, and the time required by personnel to evacuate the area.

No location in the containment zone is more than 15 sec walking time from an exit. The cell pressure-sensing switches would give the first alarm of the incident and would put the building in containment. Assuming there would be some reaction time on the part of individuals in the containment area, 2 min has been chosen as a reasonable evacuation time.

The amount of radioactive material carried by the gases escaping from the primary containment volume depends upon the size of the particles and the size of the openings through which they escape. Since these

factors are unknown, a volume of 10 mg of solids per cubic meter of gas has been used for the dose calculations. This is equivalent to the maximum stable aerosol of water droplets in air and probably represents an extreme case. It is also assumed that the radioactive material is uniformly dispersed in the secondary containment volume when it escapes from the cell and that the breathing rate of personnel in the containment zone during the emergency will be 44% faster than normal. The dose received during the 2-min evacuation can be written as:

$$D = \frac{(W)(10)(SpA)(0.1)(120)(1.44)}{(V_B)(1.44 \times 10^5)(MPCa_{40})} \text{ rem,}$$

where

W = volume of gas escaping primary containment = 2.7 ft^3,

SpA = radioactivity of entrained material, Ci/mg,

V_B = volume of containment zone = 8.093×10^4 ft^3,

$MPCa_{40}$ = maximum permissible concentration of entrained radioactive material that will give a dose of 100 mrem in a 40-hr exposure period, Ci/m^3.

For example, in the case of ^{90}Sr as the titanate (47.7% ^{90}Sr):

$$D = \frac{(2.7)(10)(6.86 \times 10^{-2})(10^{-1})(120)(1.44)}{(8.093 \times 10^4)(1.44 \times 10^5)(3 \times 10^{-10})} = 0.0915 \text{ rem.}$$

References

1. J. Nichols, Chemical Technology Division, personal communication.

2. E. D. Arnold et al., *Radiochemical Facility Hazard Evaluation*, USAEC Rpt. ORNL-CF-61-7-39, Oak Ridge National Laboratory (July 1961).

3. *Meteorology and Atomic Energy*, U. S. Department of Commerce, AECU-3066 (July 1955).

4. E. D. Arnold and J. P. Nichols, *Hazards Analysis of Fuel Handling Facilities*, USAEC Rpt. ORNL-TM-346, Oak Ridge National Laboratory (August 1962).

5. C. E. Guthrie and J. P. Nichols, *Theoretical Possibilities and Consequences of Major Accidents in* ^{233}U *and* ^{239}Pu *Fuel Fabrication and Radioisotope Processing Plants*, USAEC Rpt. ORNL-CF-63-10-34, Oak Ridge National Laboratory (October 1963).

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