X-822

ORNL
MASTER COPY

OAK RIDGE NATIONAL LABORATORY
Operated by
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation

UCC

Post Office Box X
Oak Ridge, Tennessee

Distribution Limited
to Recipients Indicated

ORNL
CENTRAL FILES NUMBER
CF-60-5-24

COPY NO. 83

DATE: May 20, 1960

SUBJECT: BUILDING 3508, ALPHA ISOLATION LABORATORY - HAZARDS EVALUATION, Vol. 9

TO: F. L. Culler

FROM: E. J. Frederick and R. E. Leuze

ABSTRACT

A hazards evaluation of the Alpha Isolation Laboratory facilities and operations indicates that the maximum credible accident potential exists in the multicurie purification programs. Dose values, computed according to the standard model and as a special case, are reported for the release of 30 g of Am^{241} and 250 g of U^{233}, respectively, from the glove box. It is concluded that sufficient safety features are built into the glove box to prevent the theoretical credible accident from ever occurring.

Standards of construction and containment, assumptions made to evaluate the potential hazards of release of radioactive material, and methods of calculation used for development of this hazards analysis are given in ORNL-2956, Summary Report - Hazards Analyses of Radiochemical Processing and Waste Disposal at Oak Ridge National Laboratory, Sects. 4.0, 5.0, and 6.0.

CONTENTS

BUILDING 3508, ALPHA ISOLATION LABORATORY

1.0 INTRODUCTION

1.1 Purpose and Use

The Alpha Isolation Laboratory was constructed and placed in operation in 1952. It was designed for working with high-level alpha, low-level beta, and gamma emitting materials and is primarily a development and service facility for chemical and analytical work.

1.2 Location and Distance from Other Facilities

The Laboratory is situated between White Oak Avenue and Fourth Street in the ORNL area (Fig. 1). The distances of various buildings from Bldg. 3508 are:

Bldg. No.	Name	β,γ Activity Inventory, curies	Distance from Bldg. 3508 ft	Direction
3517	Fission Product Processing Plant	10^6	110	West
3505	Metal Recovery Plant	250	170	West
3550	Research Laboratory Annex	<1	80	Northeast
3592	Unit Operations Volatility Laboratory	<1	140	East
3503	Solvent Column Pilot Plant	<1	100	Southeast
3504	Health Physics Waste Research Laboratory	<1	50	South

1.3 Building Description

The two-story building contains approximately 13,500 ft^2 of floor space. It is constructed of corrugated metal panels installed over a rigid steel framework and is covered with a Class II built-up tar and gravel roof. Together with Bldg. 3505 it is located in a security area with patrolled access at the west extremity of the area adjacent to Bldg. 3505 and a second entrance immediately adjacent to the southeast corner of the Alpha Isolation Laboratory. All the operating facilities are located on

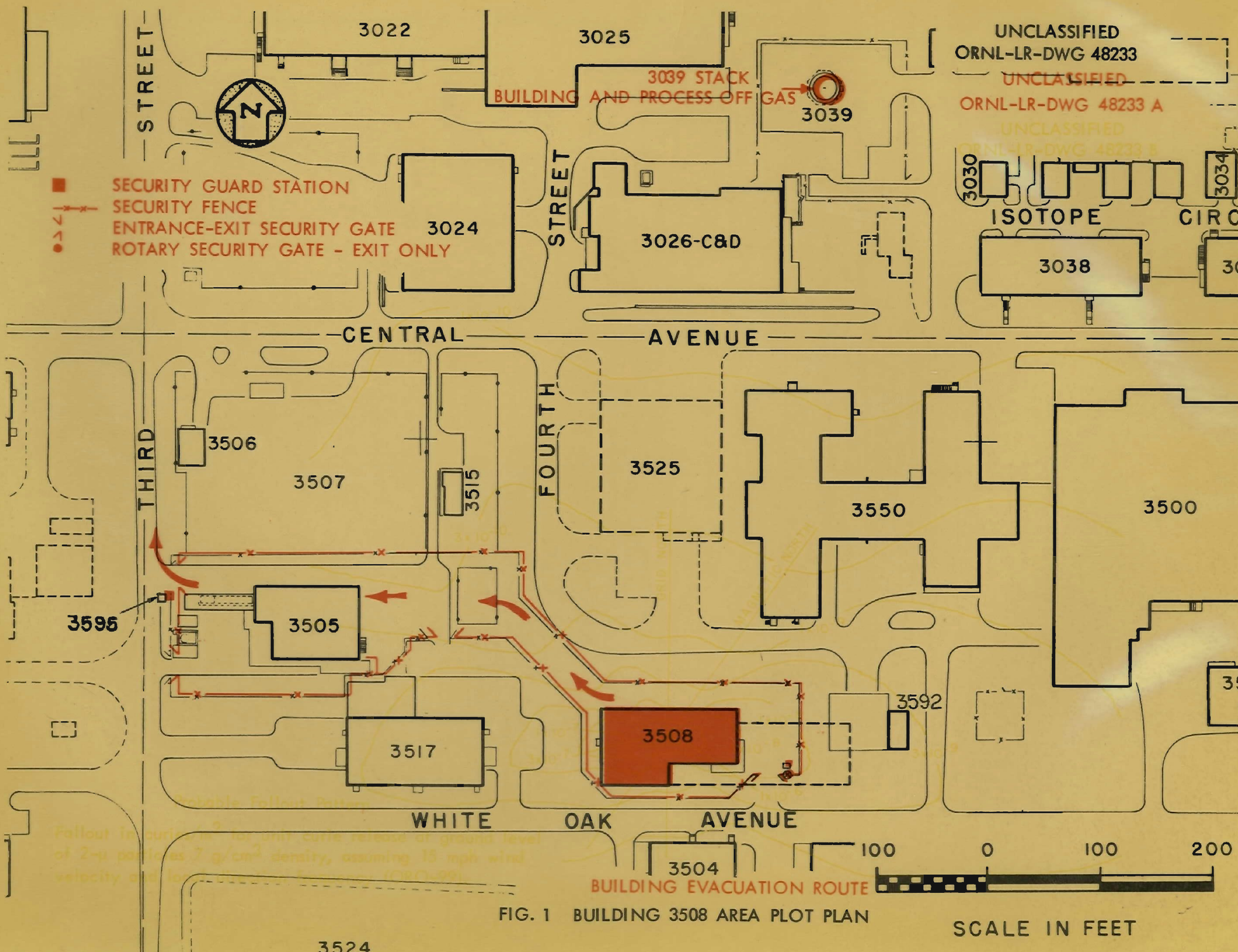

FIG. 1 BUILDING 3508 AREA PLOT PLAN

the first floor, which covers approximately 6892 ft^2 (Fig. 2). The second floor is used for housing the building service equipment (Figs. 3 and 4). Entry into the building is through the office area. Access into, and exit from, the contamination zone, i.e., the remainder of the building, is through the change room. Operations on alpha emitting material are performed in laboratories 2 and 4, with laboratories 1, 3, and 5 and the ancillary facilities providing support.

Glove boxes fabricated of either mild or stainless steel are used for primary containment in working with alpha-emitting materials. Where β and γ activities are a problem, localized lead shielding is used on the exterior of the box. The standard multicurie-level glove box is shown in Fig. 5. It is specially designed and constructed to retain its integrity in the event of an in-box fire and/or explosion.

For the laboratories the walls and ceiling of the rooms form the second line of containment. Since each is individually isolated (Fig. 6), activity does not spread from area to area. Laboratories 2 and 4 are surrounded by other areas between them and the building shell (Figs. 2 and 6); therefore the shell provides essentially a third line of containment for these laboratories. For the remainder of the building the walls and roof of the building are considered as the second line of containment. Overlays on Figs. 2, 3, 4, and 6 show the primary and secondary containment and the contamination zones.

1.4 Personnel Control

The Alpha Isolation Laboratory staff consists of 13 technical and nontechnical personnel, seven from the Chemical Technology Division and six from the Analytical Chemistry Division:

Bldg.	Weekday	Nights and Week Ends
3517	12	6
3550	67	1
3592	2	0
3503	4	0
3504	22	0
3505	7	3

Routine personnel monitoring checks are maintained at the normal exit door of each laboratory to minimize the spread of contamination. A final check is required at the exit point from the contamination zone in the change room. Monitoring locations are shown on the Fig. 2 overlay.

The emergency evacuation routine for the Alpha Isolation Laboratory is in the direction of Bldg. 3505 as shown in Fig. 1, red overlay. Personnel evacuated as a result of an incident in the Alpha Isolation Laboratory are to meet at Bldg. 3505 for monitoring and decontamination before assuming assigned emergency duties.

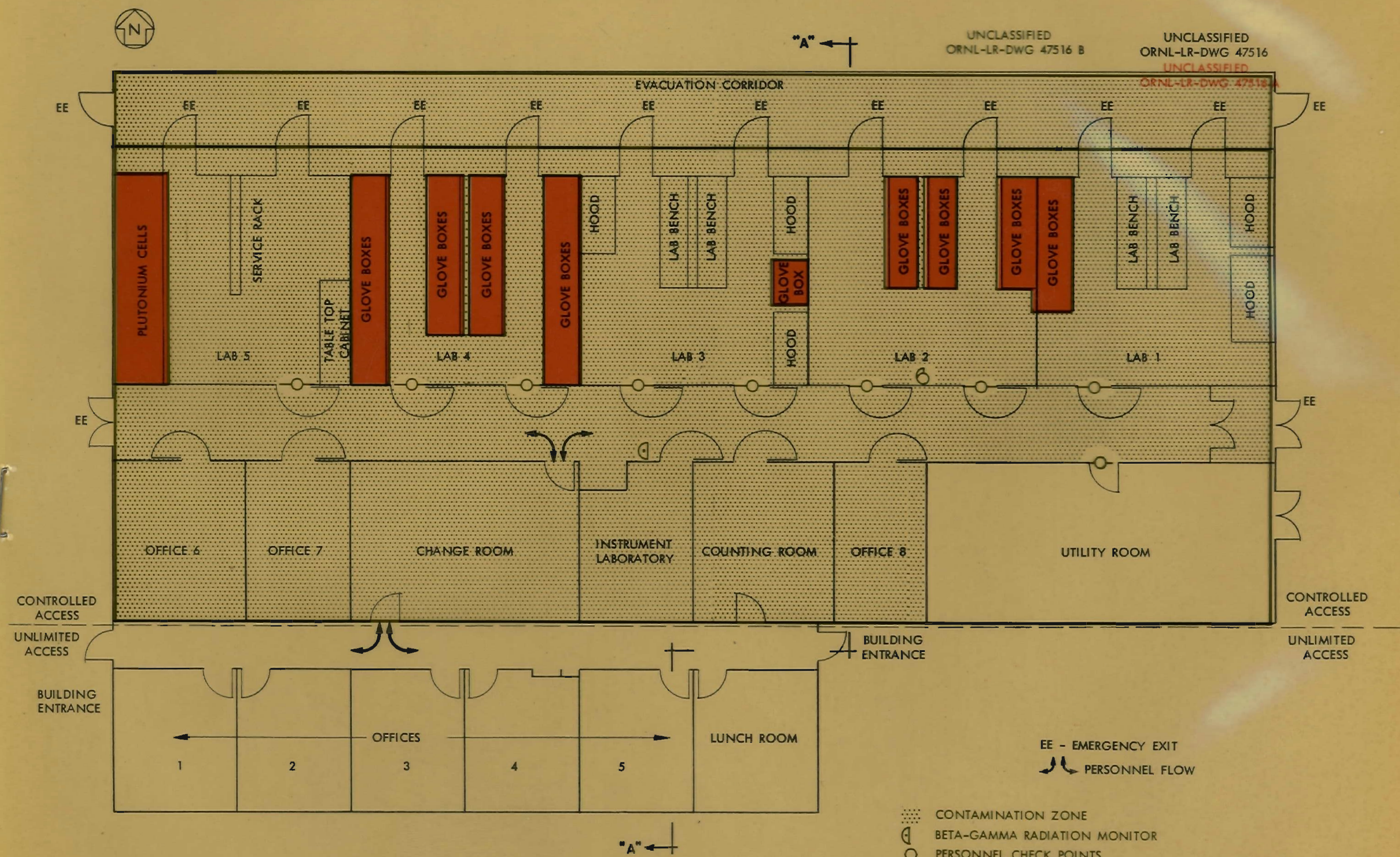

FIG. 2. BUILDING 3508 FIRST FLOOR PLAN

LIMITS OF PRIMARY CONTAINMENT

LIMITS OF SECONDARY CONTAINMENT

UNCLASSIFIED
ORNL-LR-DWG 47520
UNCLASSIFIED
ORNL-LR-DWG 47520 A

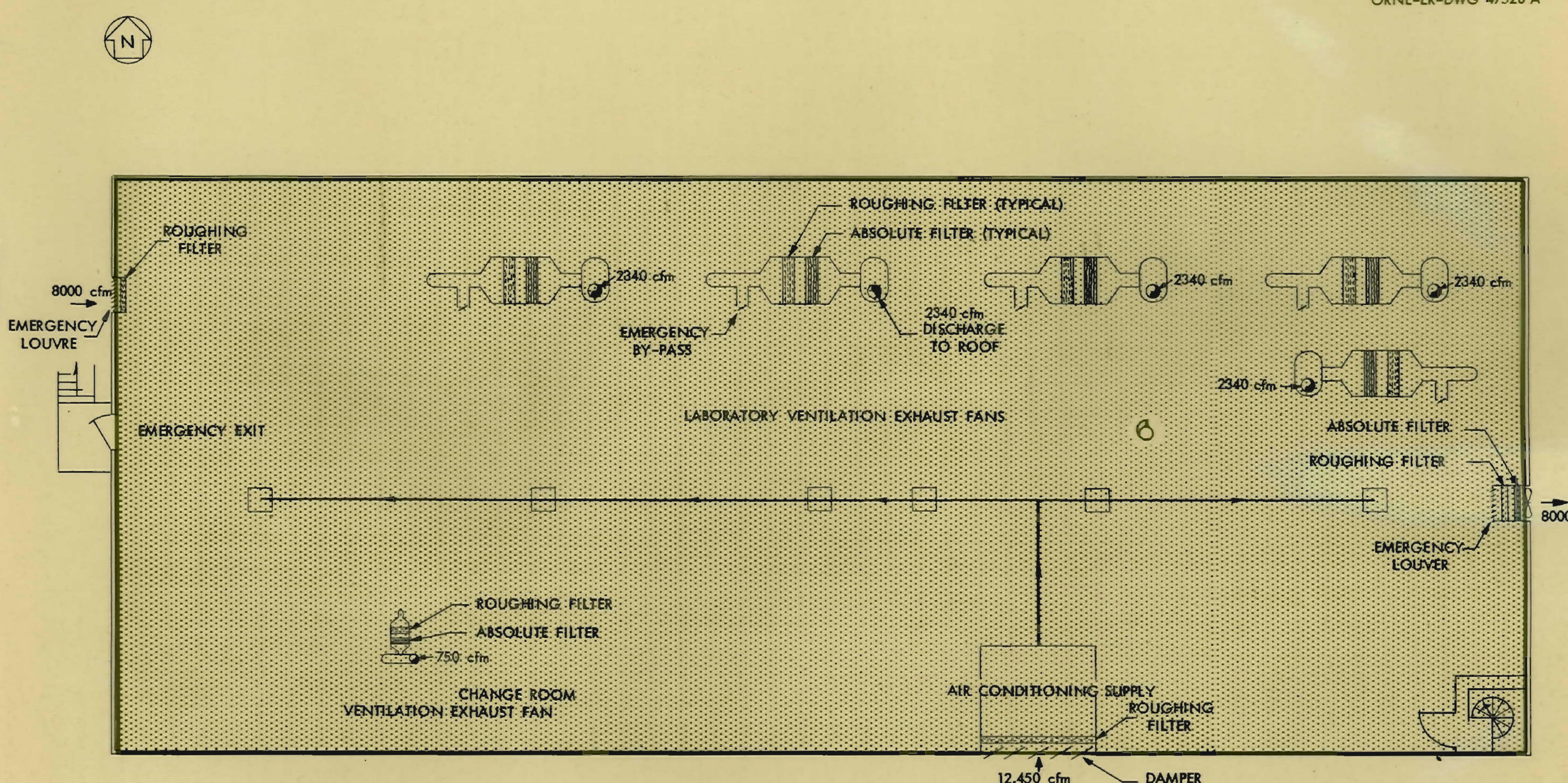

FIG. 3 BUILDING 3508 SECOND FLOOR PLAN
HEATING AND VENTILATION SCHEMATIC

AIR-BORNE ALPHA PARTICULATE ACTIVITY MONITOR
CONTAMINATION ZONE

LIMITS OF SECONDARY CONTAINMENT

UNCLASSIFIED
ORNL-LR-DWG 47521
UNCLASSIFIED
ORNL-LR-DWG 47521 A

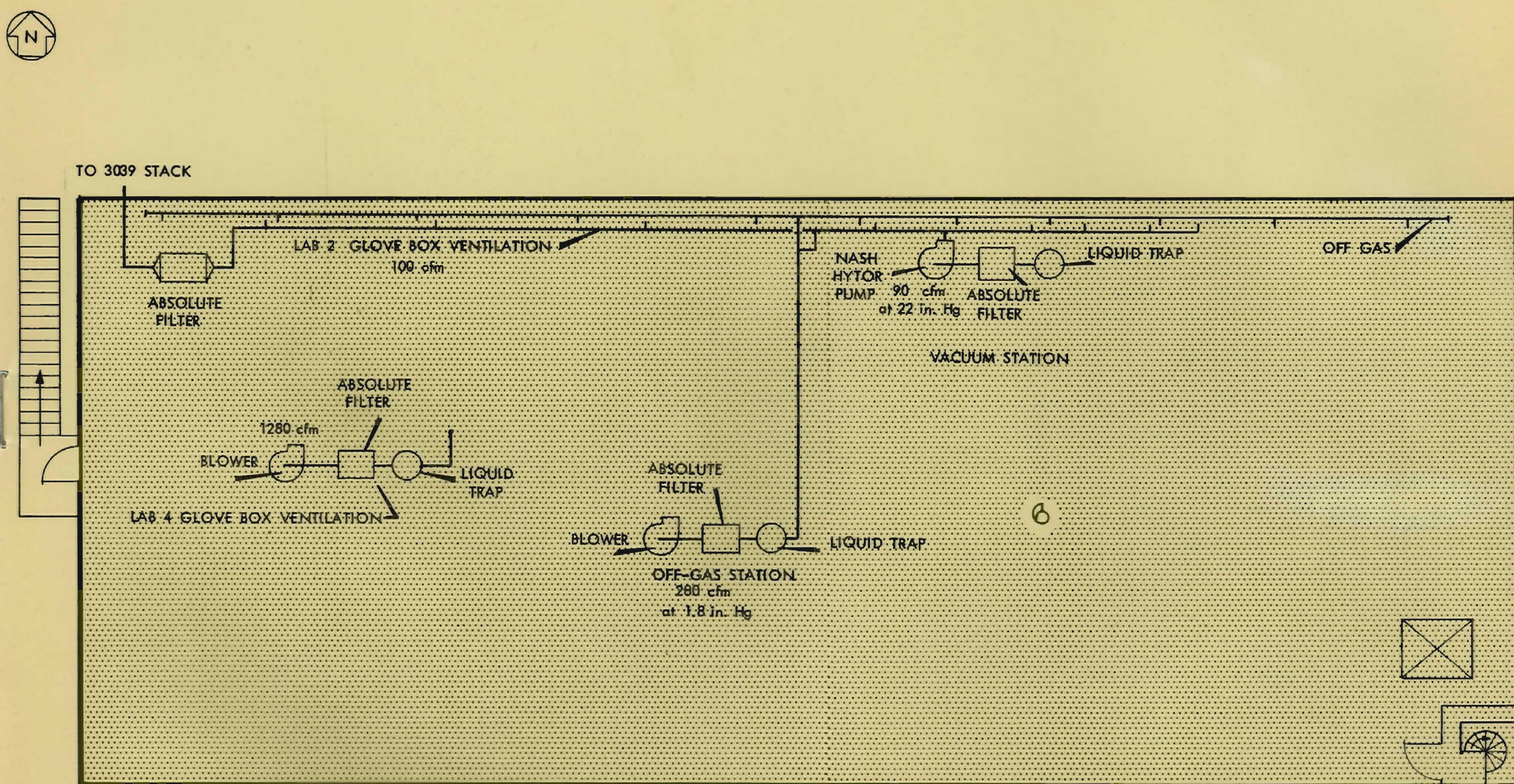

FIG. 4 BUILDING 3508 SECOND FLOOR PLAN
GASEOUS WASTE SYSTEM SCHEMATIC

AIR-BORNE ALPHA PARTICULATE ACTIVITY MONITOR
CONTAMINATION ZONE

LIMITS OF SECONDARY CONTAINMENT

UNCLASSIFIED
ORNL-LR NO. 48749

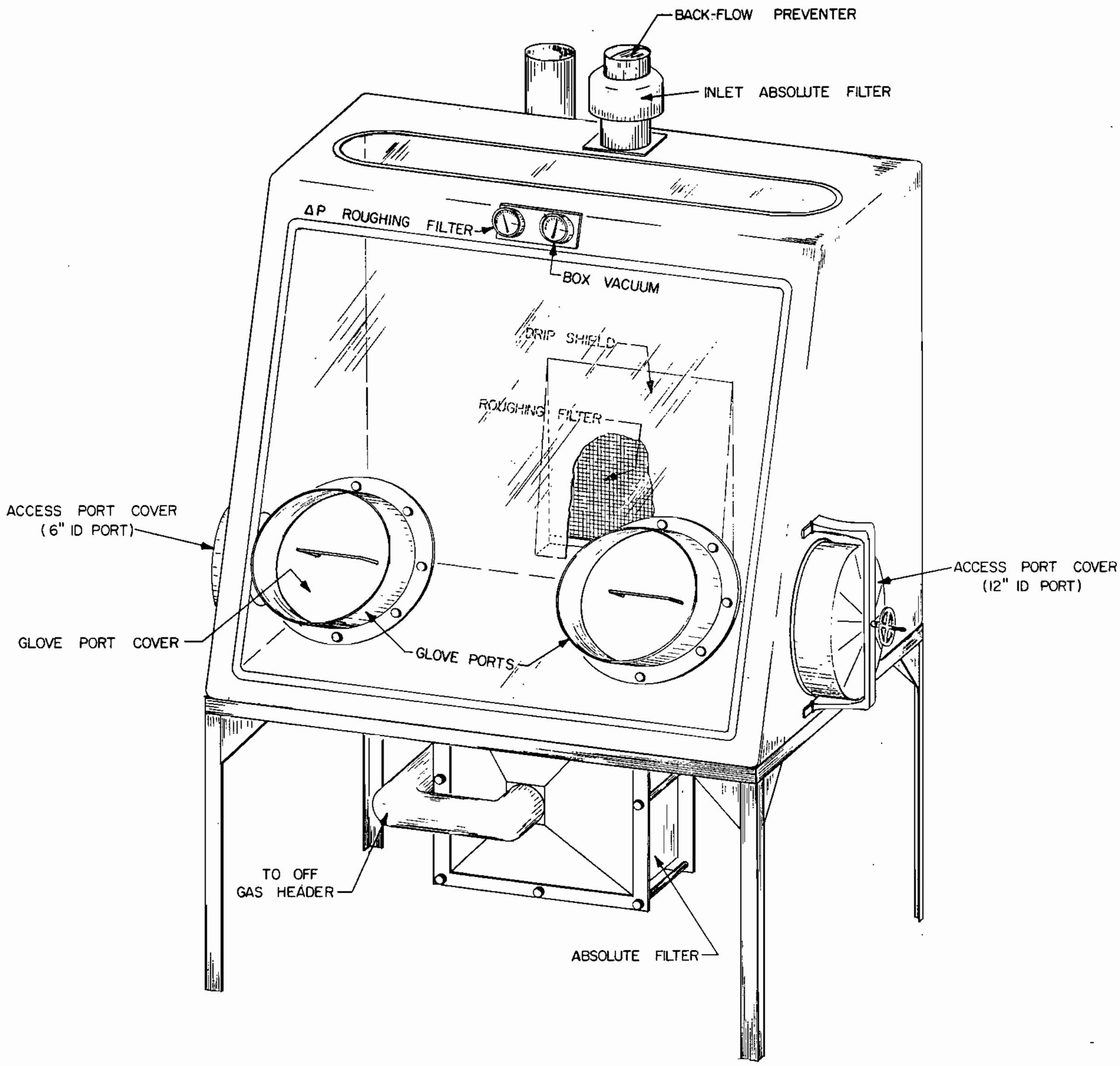

FIG. 5. MULTICURIE LEVEL ALPHA GLOVE BOX

UNCLASSIFIED
ORNL-LR-DWG 48750
UNCLASSIFIED
ORNL-LR-DWG 48750B
UNCLASSIFIED
ORNL-LR-DWG 48750A

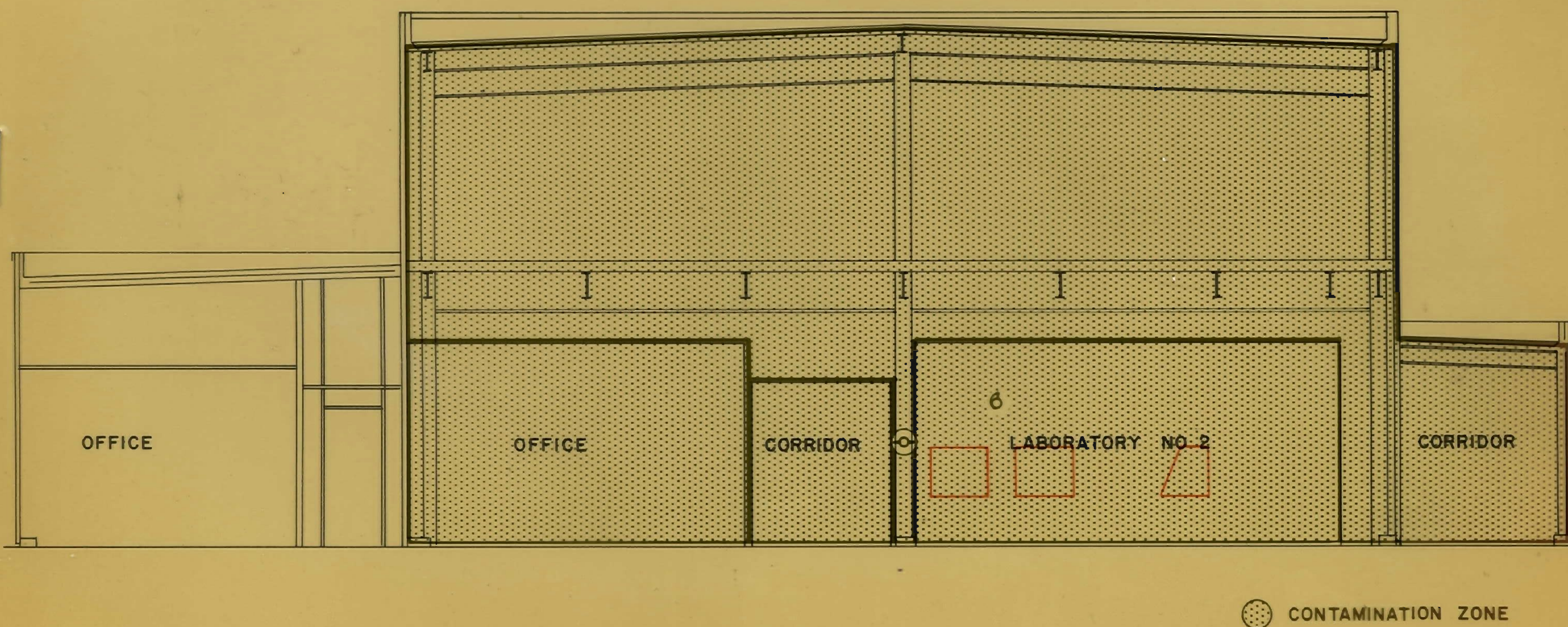

FIG. 6 BLDG. 3508 SECTION THRU BLDG.
LIMITS OF SECONDARY CONTAINMENT
LIMITS OF PRIMARY CONTAINMENT

1.5 Process Description

Solvent extraction and ion exchange are used most frequently in developing processes for separating and isolating alpha-emitting material. The scale of operation ranges from 0.1 to 1.0 liter and involves tracer activity levels. Associated service program operations vary. A recent program in which 180 g of Am^{241} chloride solution was converted to the powdered oxide required working with up to 30 g of Am^{241} in solution volumes ranging from 0.1 to 4.0 liters. This is a factor of 100 greater than the amount that would be normally handled in a routine glove box operation. Programs of this nature require special review and approval, and adequate precautions must be taken to prevent the accidental release of activity from the glove box. An equipment schematic for the intermediate steps in the Am^{241} process is shown in Fig. 7.

1.6 Criticality

The amount of fissionable material now handled in the Alpha Isolation Laboratory is well below the critical limit. If operation levels are extended and criticality is a problem, the following regulations will be enforced, which are well below the critical limit for any geometry,

	Batch size/operation, g	Inventory in Bldg., g
Pu^{239}	250	350
U^{233}	250	350
Am^{241}	Unlimited by Criticality	Unlimited by Criticality

1.7 Liquid Waste Systems

Sanitary, process, and radioactive liquid wastes are found in Bldg. 3508. The latter two systems are shown in Figs. 8 and 9. All process and radioactive wastes are collected and monitored before discharge. The treatment and procedures for disposal of the various waste solutions are:

System	Source	Volume, gal/day	Treatment	Final Disposal
Sanitary	Sanitary facilities in change room except showers, which discharge to process waste	250	None	Sanitary waste system
Process	Nonradioactive but may become active in event of accident	250	Collect in 2000-gal holdup tank, sample, and analyze	Process or radioactive waste system as required

UNCLASSIFIED
ORNL-LR DWG 48753

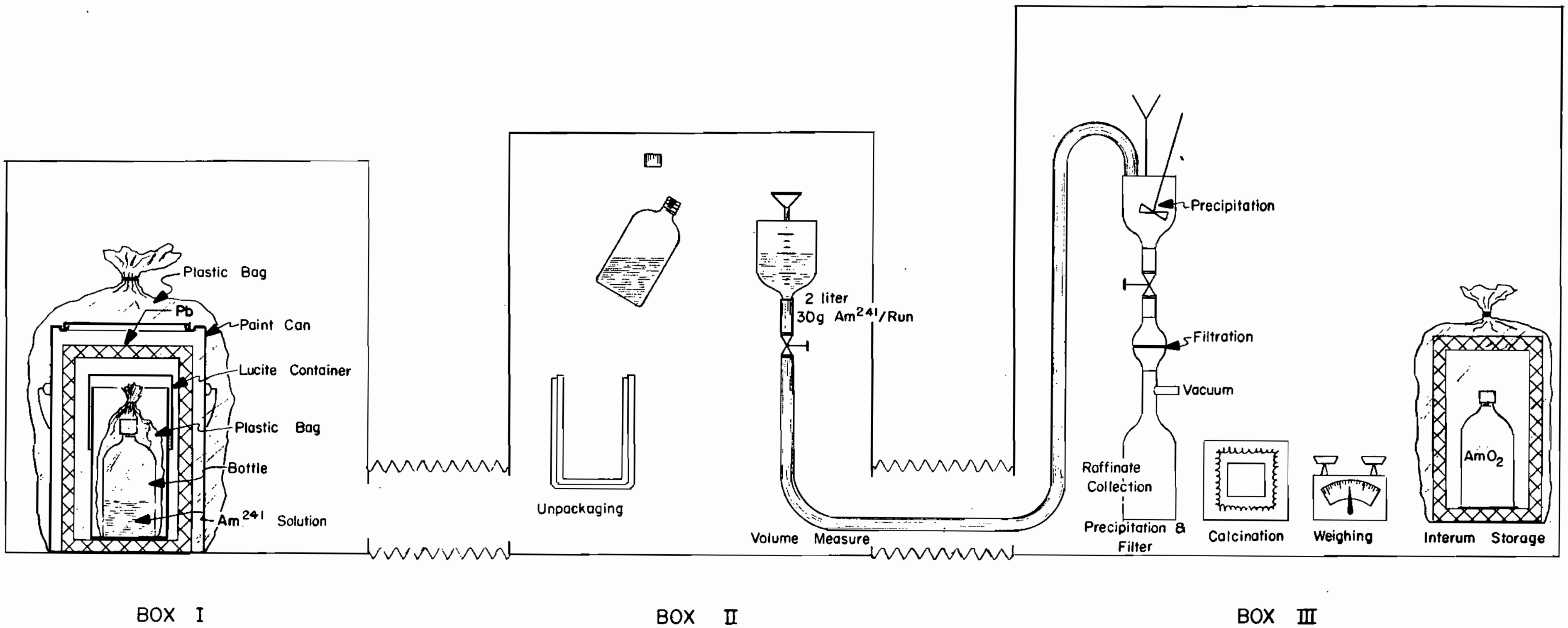

FIG. 7 Am^{241} PROCESSING EQUIPMENT SCHEMATIC

UNCLASSIFIED
ORNL-LR-DWG 47517

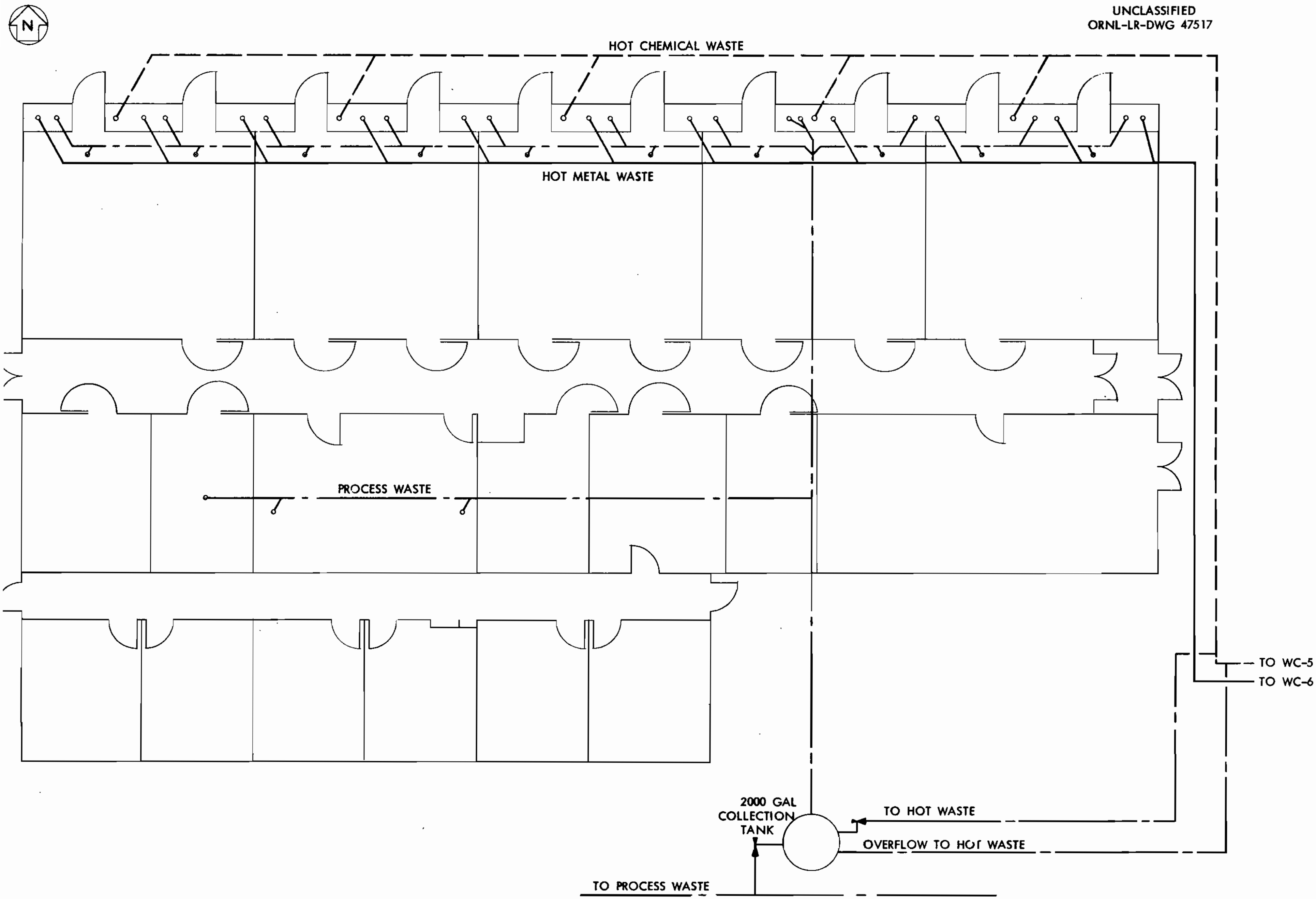

FIG. 8 BUILDING 3508 FIRST FLOOR PLAN
DRAIN SYSTEMS SCHEMATIC

UNCLASSIFIED
ORNL-LR-DWG 47518

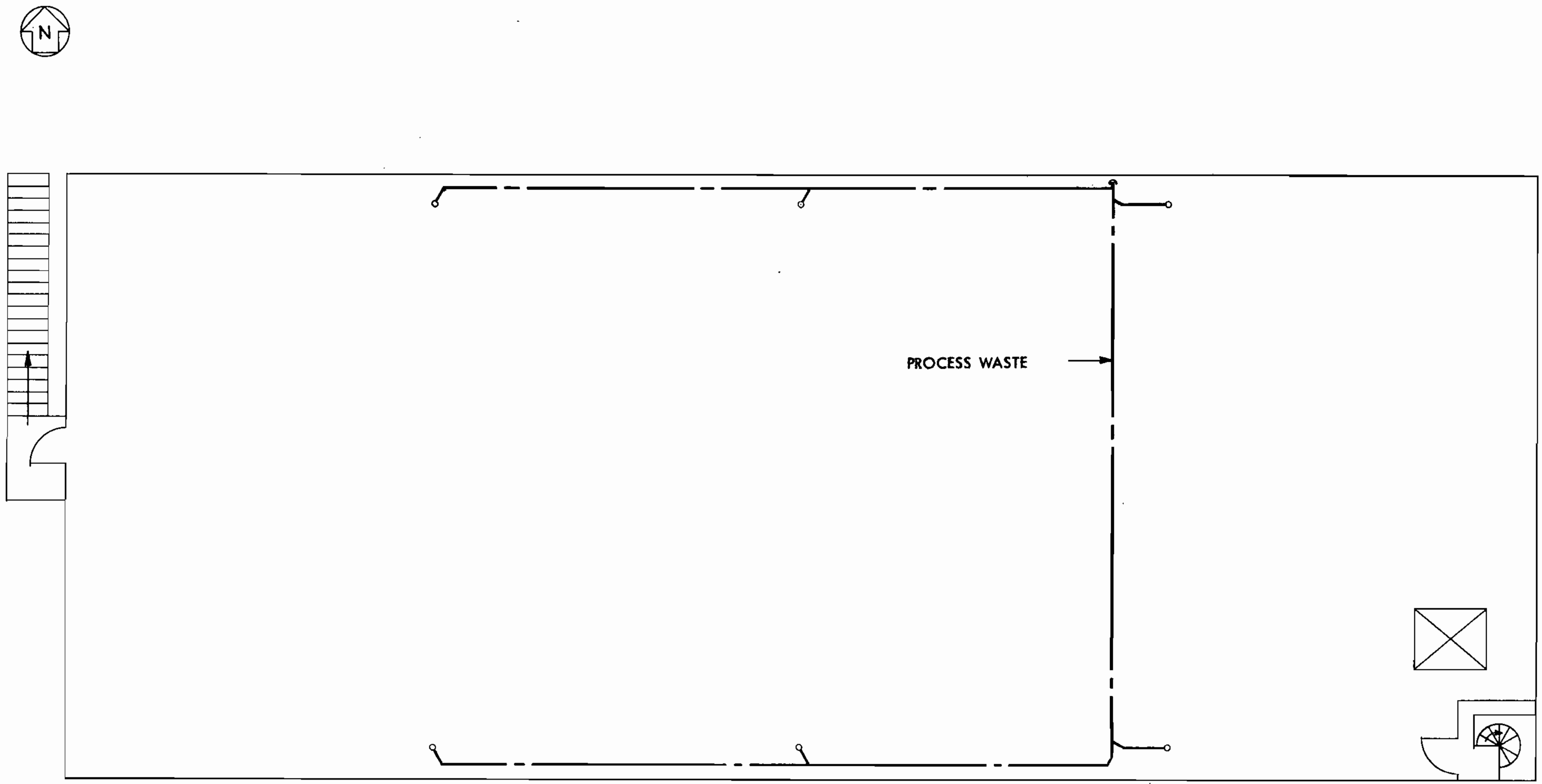

FIG. 9. BUILDING 3508 SECOND FLOOR PLAN
FLOOR DRAINS SCHEMATIC

System	Source	Volume, gal/day	Treatment	Final Disposal
Radioactive chemical	Laboratory benches and glove box line, room 4	20	Collect in 1000-gal holdup tank WC-5, sample, and analyze	Radioactive waste system, tank W-9
Radioactive metal	Laboratory bench hoods	5	Collect in 500-gal holdup tank WC-6, sample, and analyze	Radioactive waste system, tank W-9

1.8 Gaseous Waste Systems

Gaseous wastes emanating from the operation of the Alpha Isolation Laboratory include building ventilation air, glove box ventilation air, Laboratory vacuum service, and laboratory off-gas service. A schematic of the building ventilation flow is shown in Fig. 10, and schematics of the ventilation distribution and the ventilation collection and cleanup systems are shown in Figs 11 and 3. All ventilation air supplied to the contaminated zone is filtered at the point of entry and all air exhausted from the contaminated zone is filtered through absolute filters before local discharge. In addition, dampers located on all supplies and on the attic exhaust automatically close in emergency, permitting evacuation and operation of the building under -0.3 in. H_2O pressure.

A schematic flow of the multicurie glove box ventilation system of laboratory 2 is shown in Fig. 12. Air is introduced into the box from the laboratory room through an absolute filter at a standard flow of 5 cfm. The box exhaust is filtered through a roughing filter followed by an absolute filter at the box discharge point. A second absolute filter is used for final cleaning of the accumulated exhausts before discharge from the building. Final disposition is the 3039 stack. The glove box system is designed to operate at -0.35 in. H_2O pressure at flows from 5 to 30 cfm. A plenum or surge tank in the exhaust header maintains smooth operating characteristics. Backflow preventers are used to eliminate flow from the box back into the laboratory.

The glove box ventilation system of the analytical lines in room 4 is similar in design to the multicurie system except that the exhaust is discharged locally after flow through the second absolute filter. Less than 1 g and 1 mg of material per operation are handled in the analytical glove boxes and glove box hoods, respectively.

The laboratory vacuum and off-gas services are both filtered through absolute filters following a liquid trap and are discharged locally (Fig. 4). A valve in the laboratory off-gas header permits exhausting the multicurie glove box ventilation system in case of emergency. Pertinent information on the handling of the laboratory gaseous wastes is shown in Table 1.

UNCLASSIFIED
ORNL-LR-DWG 48751

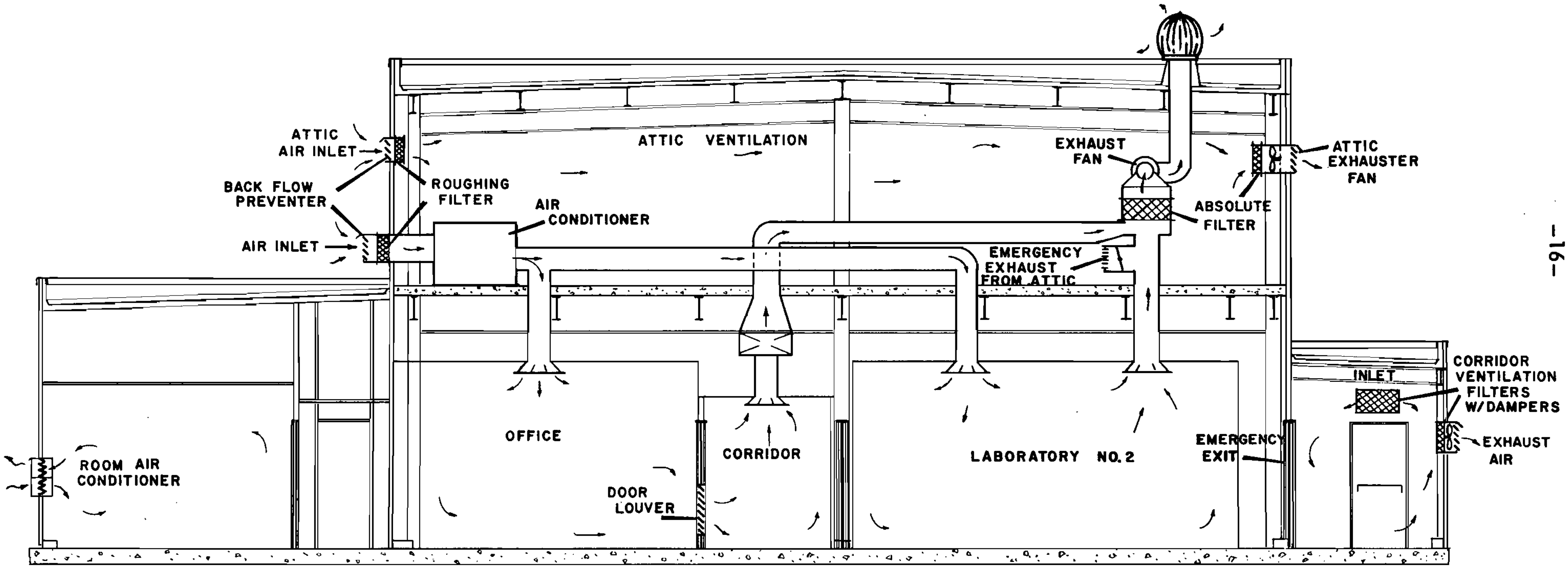

FIG. 10. BLDG. 3508 VENTILATION SCHEMATIC
SECTION "A-A"

UNCLASSIFIED
ORNL-LR-DWG 47519

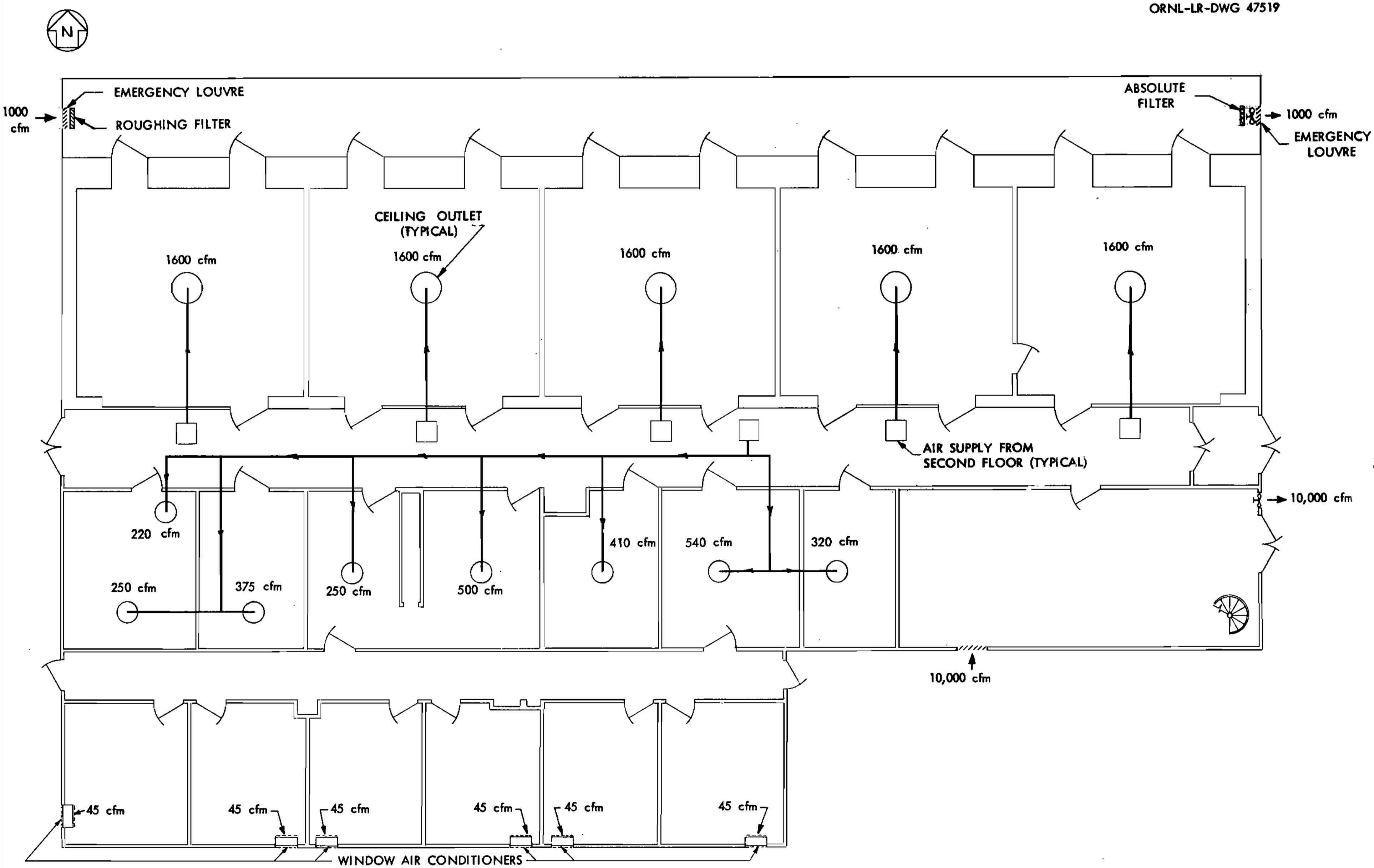

FIG. 11 BUILDING 3508 FIRST FLOOR PLAN

HEATING AND VENTILATING SCHEMATIC

UNCLASSIFIED
ORNL-LR-DWG 48754

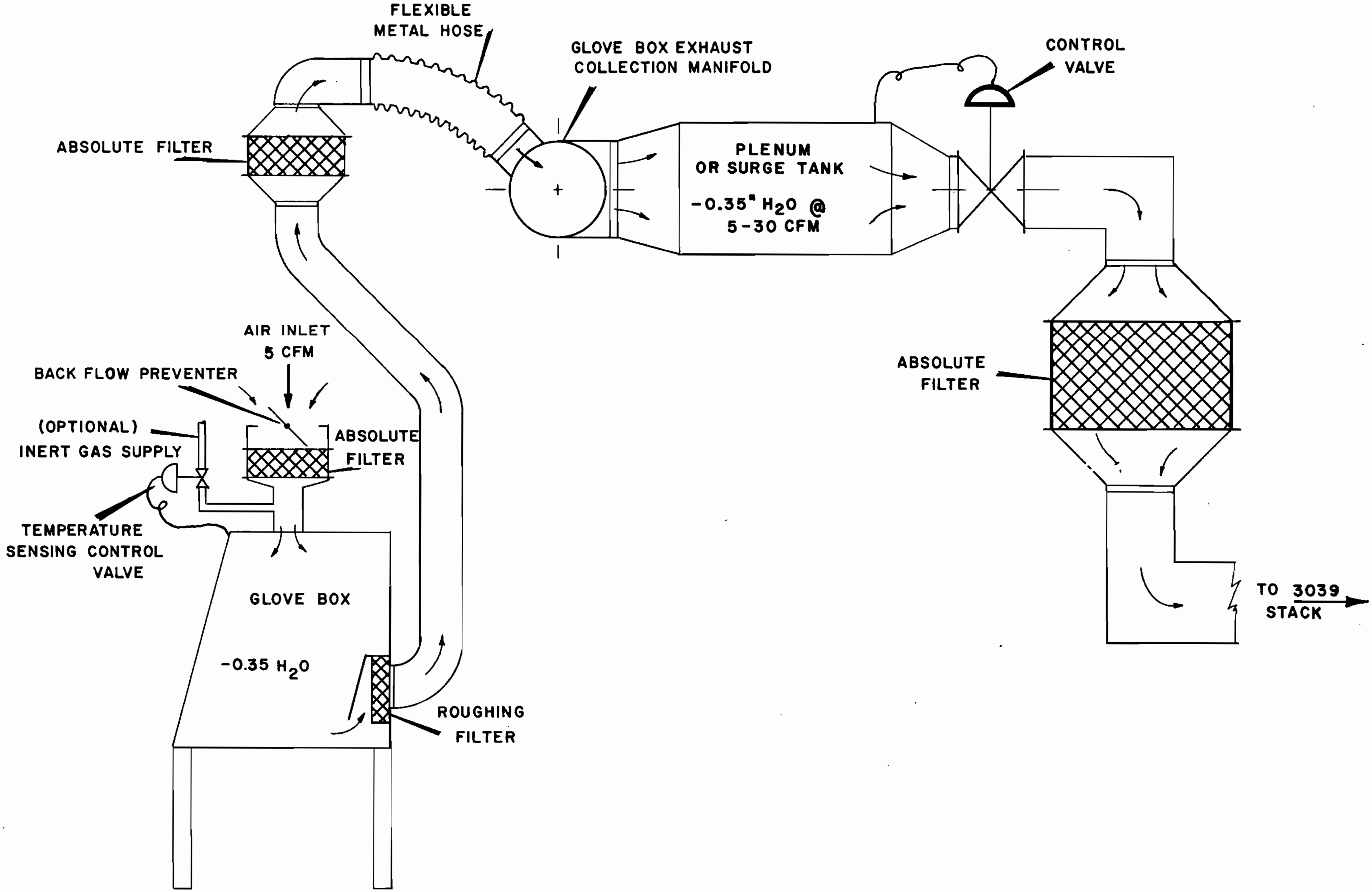

FIG. 12. GLOVE BOX VENTILATION SCHEMATIC

Table 1. Alpha Isolation Laboratory Gaseous Waste Treatment

Service	Zone	Equipment	Capacity, cfm	Treatment Supply	Treatment Exhaust	Usual Disposition	Emergency Disposition
Office ventilation	Unlimited	Window air conditioners	270	Dust stop filter	None	Recycle	Recycle
Mechanical room ventilation	Controlled	Exhaust fan suction; temperature controlled inlet and exhaust louvers	10,000	None	None	Local	Local
Ist floor ventilation	Contaminated	63-ton central air-conditioned supply and distribution system; individual laboratory room exhaust collection and processing system in utility room; damper on supply	12,450	90% NBS filter	90% NBS prefilter followed by 99.97% absolute filter	Local	Local
Ist floor emergency corridor	Contaminated	Exhaust fan suction; temperature controlled inlet and exhaust louvers; dampers on supply and exhaust	1,000	90% NBS filter	90% NBS prefilter followed by 99.97% absolute filter	Local	Into laboratories under vacuum
Utility room ventilation	Contaminated	Exhaust fan suction; temperature controlled inlet and exhaust louvers; dampers on supply and exhaust	8,000	90% NBS filter	90% NBS prefilter followed by 99.97% absolute filter	Local	Into laboratory room exhaust system upstream from filters

Service	Zone	Equipment	Capacity, cfm	Supply	Exhaust	Usual Disposition	Emergency Disposition
Multicurie glove box ventilation, laboratory 2	Contaminated	Supply from laboratory room at 5 cfm into box; backflow preventer on box; box operated at -0.35 in. H_2O pressure; exhaust capacity 5-30 cfm with no detectable pressure rise	100	99.97% absolute filter	FG-50 filter at box followed by 99.97% absolute filter; final 99.97% absolute filter on header at exit from building	3039 stack	3039 stack into laboratory off-gas system upstream from filter when 3039 stack is not operating
Analytical glove box ventilation, laboratory 4	Contaminated	Supply from laboratory at 5 cfm into boxes with gloves; 200 cfm without gloves; operating characteristics of boxes with gloves same as multicurie glove box; characteristic of boxes without gloves same as laboratory hands	1,280	99.97% absolute filter on boxes with gloves; no prefiltration into boxes without gloves	FG-50 filter at box followed by 99.97% absolute filter; final 99.97% absolute filter on header following liquid trap prior to exit from building	Local	Local
Laboratory vacuum service		Vacuum supplied by Nash Hytor pump preceded by filter and liquid trap; laboratory bench service and room 4 glove box service; glove box system has an initial liquid trap and filtration prior to discharging to final cleanup system	90 cmf at 22 in. Hg	None	99.97% absolute filter located after each liquid trap	3039 Stack	3039 Stack
Laboratory off-gas service		Vacuum supplied by Hoffman type 41 blower; liquid trap and filter precede blower; laboratory hood and bench service	280 cfm at 1.8 in. Hg	None	99.97% absolute filter located between blower and liquid trap	Local	Local

1.9 Monitoring

Continuous air sampling and monitoring alpha, beta, and gamma instruments are located in laboratories 2 and 4, and a stationary air alpha sampling unit is located in the second floor utility room. A stationary beta-gamma air sampling unit is located in the intermediate corridor between the laboratories and change room. Portable gas-flow alpha survey meters are used to monitor glove box operations in the laboratory and to monitor personnel before exit from the laboratory and in the change room as a final check before leaving the contamination zone. Daily smear counts of the whole laboratory are standard procedure for further maintaining contamination control.

2.0 SUMMARY*

2.1 Radioactive Material Content of the Alpha Isolation Laboratory

Material	Design Capacity	Inventory In Plant	Inventory in Largest Vessel
Mixed nonvolatile fission products, curies	-	2000	2000
U^{233}, kg	0.25**	0.500**	0.25**
Am^{241}, curies	100	620	560
Cm^{242}, curies	-	10	-

**Future program.

2.2 Criticality Incident Potential

Existing programs present no criticality potential. If criticality must be observed in future programs, batch control will be followed. A single batch will contain 250 g maximum.

2.3 Explosion and Fire Potential

a. Properties of solvent in use and potential energy release to glove box:

*Calculations and assumptions are given in Volume 1 of this series of reports. Glove box processing of 30-g amounts of Am^{241} and 250-g amounts of U^{233} was selected for analysis in maximum credible accident evaluation.

	Amsco 125-82	o-Xylene
Closed cup flash point, °F	128	63
Explosive limit in air, %	1.1-6.1	1.0
Energy release upon combustion, Btu/lb	19,000	18,500
Inventory in glove box, liters	2.0	2.0
Total energy release to box, Btu	62,700	72,100

b. Radiolytic Gas Buildup Hazard, assuming box ventilation system fails for 24 hr; vessel is vented to glove box:

	250 g U^{233}	30 g Am^{241}
Volume of H_2 gas evolved, cc/day	4	1410
Volume of box, cc	4.52×10^5	4.52×10^5
Final concentration, cc H_2/cc air*	8.87×10^{-6}	3.1×10^{-3}

c. Solvent Vapor Explosion Hazard, assuming box ventilation system fails; box fills with air and the solvent is stored in an open container:

	Amsco 125-82	o-Xylene
Inventory in box, cc	2.0×10^3	2.0×10^3
Box volume, cc	4.52×10^5	4.52×10^5
Explosive limit in air, %	1.1	1.0
Closed cup flash point, °F	128	63

It is evident that radiolytic gas buildup does not consitute an explosion hazard if the box ventilation should fail. o-Xylene on the other hand constitutes no hazard only as long as the solvent temperature can be retained below the closed cup flash point temperature.

The following practices are followed in order to further minimize the explosion and fire hazard potentials in glove boxes:

1. During all solvent extraction operations an inert gas purge is used on the glove box ventilation system. The flow is regulated to keep the oxygen content of the box atmosphere below 2 vol %. In normal operation the purge system is utilized as a medium for extinguishing glove box fires. It is actuated by a temperature sensing control mounted in the box.

2. Highly volatile solvents such as xylene have cooling built into storage reservoirs to decrease vaporization.

*Explosive limit of hydrogen in air = 4.1 volumes %.

3. Explosion-proof electrical equipment is used where possible.

4. All glove box interior surfaces are painted with noncombustible phenoline 304 paint.

5. When large quantities of heat are generated such as in a furnace operation, localized cooling of the equipment is provided to prevent heat buildup and temperature rise in the box.

6. In the analytical laboratory, all perchloric acid fuming operations must be preceded by at least one nitric acid pre-oxidation fuming step to lessen the possibility of an explosion. Buildup of perchloric acid fume concentration is prevented by local scrubbing before discharge to the off-gas system.

7. Portable CO_2 extinguishers are available for use in hoods and glove boxes when the gloves have been removed.

The probability of an explosion and/or fire in the multicurie glove box operations is virtually nonexistent but cannot be discounted completely. However, the adaptation of the standard glove box design, with its special built-in features (Fig. 5) for these operations, makes it reasonable to assume that either a fire or explosion of the type that can be produced in the present scope of glove gox operations can be adequately contained.

2.4 Evaluation of Noncriticality Event Leading to the Release of Radioactive Materials

Calculations have been made for the maximum integrated downwind dose for the release of activity into the vessel off-gas system and the cell ventilation system. Two sets of data are presented: one for the analysis based on the standard model as outlined in Volume I of this report, and a second, designated "special," based on the following assumptions:

1. The dry box is considered as a vessel, the room as a cell, and the corridor adjacent to the laboratory room as the secondary containment. Volume of corridor = 7680 ft^3.

2. Maximum operator dose is integrated over 15 sec instead of 2 min, i.e., the time it takes the operator to safely adjust respirator mask.

3. Based on data for UO_3 suspensions, the suspension of UO_3 or AmO_2 released would contain 0.3 mg/m^3 instead of 10 mg/m^3.

The data are:

	Standard		Special	
Vessel off-gas release	U^{233}	Am^{241}	U^{233}	Am^{241}
Total amount, curies	-	-	6.4×10^{-9}	1.73×10^{-4}
Max downwind integrated dose, rem	-	-	<0.001	<0.001
Distance downwind of dose, m	-	-	150	150
Cell off-gas release				
Total amount, curies	6.4×10^{-8}	1.73×10^{-3}	-	-
Max downwind integrated dose, rem	<0.001	0.0046	-	-
Distance downwind of dose, m	150	150	-	-

2.5 Effect of Accidental Release of Radioactive Material to the Secondary Containment Zone

	Standard		Special	
	U^{233}	Am^{241}	U^{233}	Am^{241}
Release into secondary containment zone				
Total amount, curies	1.5×10^{-3}	4.0	4.5×10^{-5}	1.2×10^{-1}
Concentration, curies/m^3	1.0×10^{-5}	2.7×10^{-2}	3.0×10^{-7}	8.1×10^{-4}
Dose to building personnel, rem	1.0×10^{1}*	5.4×10^{5}*	3.6×10^{-2}**	2.0×10^{3}**
Release from secondary containment zone (Assuming ventilation system does not fail)				
Total amount, curies	2.4×10^{-5}	6.5×10^{-2}	6.3×10^{-7}	1.7×10^{-3}
Max downwind integrated dose, rem	<0.001	1.87	<0.001	0.05
Distance downwind of dose, m	150	150	150	150
Ground fallout at 20 m, curies/m^2	9.5×10^{-11}	2.4×10^{-7}	2.5×10^{-12}	6.3×10^{-9}
Distance downwind to which ground would be contaminated to hazardous level, m	0	6	0	0
Distance downwind to which ground must be decontaminated, m	0	45	0	8

*2-min dose.

**15-sec dose.

	Standard		Special	
	U^{233}	Am^{241}	U^{233}	Am^{241}
Release from secondary containment zone (Assuming ventilation system fails)				
Total amount, curies	6.0×10^{-5}	1.53	7.5×10^{-6}	1.9×10^{-2}
Max downwind integrated dose, rem	<0.001	43.0	<0.001	0.54
Release from secondary containment zone				
Distance downwind of dose, m	150	150	150	150
Ground fallout at 20 m, curies/m^2	2.2×10^{-10}	5.6×10^{-6}	2.7×10^{-11}	6.9×10^{-8}
Distance downwind to which ground would be contaminated to hazardous level, m	0	46	0	5
Distance downwind to which ground must be decontaminated, m	0	250	0	24

Reports in This Series

Vol. 1	Summary Report of Hazards Evaluation	ORNL-2956
Vol. 2	General Description of Oak Ridge Site and Surrounding Areas	CF-60-5-27
Vol. 3	Description of ORNL Liquid Waste Systems	CF-60-5-28
Vol. 4	Detailed Assessment of Solid and Liquid Waste Systems	CF-60-5-29
Vol. 5	Hazards Report for Building 3019	CF-60-5-20
Vol. 6	Hazards Report for Building 3505	CF-60-5-21
Vol. 7	Hazards Report for Building 2527 and PRFP High Level Waste Tanks	CF-60-5-22
Vol. 8	Hazards Report for Building 3026	CF-60-5-23
Vol. 9	Hazards Report for Building 3508	CF-60-5-24
Vol. 10	Hazards Report for Building 4507	CF-60-5-25
Vol. 11	Hazards Report for Building 3517	CF-60-5-26

3.0 PLANT AND PROCESS DESCRIPTION

3.1 Facilities Description

The Alpha Isolation Laboratory is a two-story building constructed of removable corrugated metal panels installed over a rigid steel framework. It is covered by a class II built-up tar and gravel roof. The building contains approximately 13,500 ft^2 of usable floor space. The first floor (~6890 ft^2) is used for administrative work and the second floor for housing the building service equipment. Plans of the first and second floor facilities and equipment are shown in Figs. 2, 3, and 4 and a section through the building in Fig. 6. During operation the two floors are completely isolated from one another (Fig. 6, green overlay). The administrative area is located at the southwest corner of the first floor. It is an area of unlimited access, and normal access to the building is through it. The utility room at the southwest corner of the building is operated as a noncontaminated controlled-access area. It is used for dispensing chemicals, equipment, and supplies into the building. The remainder of the building, both first and second floors, is a contaminated zone (green overlay, Figs. 2 and 6) to which normal access is only from the administrative area via the change room. Table 2 lists the first floor facilities and the function of each. All operations on alpha emitters of high specific activity are performed in laboratories 2 and 4.

The interior partition walls of the first floor facilities, except the utility room, are of metal panel construction. The entire first floor, excluding the utility room, has a continuous suspended ceiling which serves as a containment barrier and prevents service lines and structural members from becoming contaminated in the event of an accident in which alpha particles are disbursed into the laboratory room. Lighting is daylight fluorescent type, and the fixtures, along with the air conditioning inlet diffusers, are recessed and sealed into the suspended ceilings. Floor coverings in the general purpose laboratories and the ancillary facilities are asphalt tile. In the alpha laboratories 2 and 4, a continuous surface of Fiberglas-cloth-reinforced liquid tile terminating in a 6-in.-high curb around the perimeter of the room contains activity and facilitates decontamination.

The general purpose laboratories 1 and 3 are equipped with metal laboratory furniture and stainless steel hoods. Air, vacuum, natural gas, and potable water services are available on the laboratory bench and hot and cold water and distilled water at each bench sink. Special 2-in.-dia cup sinks are located at each work station. All the cup sinks and the bench sinks located in the right side of the center island bench discharge into the process water system. The sinks in the left side of the center island bench discharge to the "hot" chemical waste system.

Air, vacuum, off-gas, and water service is provided to each hood. Two cup sinks, 12 in. dia, are located in the hoods. These drain to the high-activity-level waste systems. The hoods are designed to operate with a minimum face velocity of 100 ft/min. This is generally exceeded, however, since the hoods are utilized to exhaust ventilation air from the room in sufficient quantities to meet the standard requirement of 10 air changes minimum per hour.

Table 2. Building 3508, First Floor Facilities

Room	Function
Laboratory 1	Low-level beta-gamma tracer work; storage of alpha-contaminated glove boxes
Laboratory 2	High-level alpha development laboratory
Laboratory 3	Low-level (<10 μg Pu) analytical laboratory
Laboratory 4	High-level alpha analytical laboratory
Laboratory 5	Alpha spectrophotometric and high-pressure laboratory
Utility room	Material receiving, air conditioning, and electrical equipment room
Offices 6, 7, 8	Contaminated zone administration
Change room	Isolation barrier between contamination zone and unlimited-access zone; personnel clothes-changing facilities
Counting room	Radiochemical analytical counting operations; pulse-height analyses
Instrument Laboratory	Spectrophotometric investigations on natural U solution

The alpha laboratories are equipped with glove boxes fabricated of stainless steel or mild steel painted with noncombustible phenoline 305 paint. The multicurie glove box shown in Fig. 5 is used exclusively in the research and development and service programs operated in laboratory 2. The box and its ventilation system are specially designed to retain their integrity in the event of a fire or an explosion. The relatively short-term operations and programs make it desirable to incorporate flexibility and mobility as part of the operating philosophy in laboratory 2. Therefore all service tie-ins to the box are made with nonrigid connectors. In laboratory 4, the analytical laboratory, standard Los Alamos box designs are used. Because of the repetitive nature of the analytical operations the glove boxes are installed in a continuous modular arrangement with rigid connectors. Several of the boxes are installed for use as glove box hoods, i.e. boxes with the gloves removed. Only those analytical operations in which less than 1 mg of plutonium is involved may be performed in the glove box hood. Operations requiring the use of larger amounts must be performed in a totally enclosed box.

Each alpha laboratory has three totally enclosed service racks for dispensing operating services to the glove box locations. These racks are located one each along the east and west wall and a double rack extending from the north wall out into the center of the laboratory rooms. Distilled water, vacuum, air, natural gas, cold and hot water, and off-gas for glove box ventilation are standard services in all the service racks. In addition, process waste service is available in the rooms 1 and 2 service racks and the center rack in room 4. The east and west rack in room 4 contains "hot" metal waste services, and the center rack, in addition to the process waste, contains "hot" chemical waste service.

The glove boxes are operated under a -0.35 in. water gage pressure with respect to the room ventilation system. This ensures that any leakage will be into the box and aids in preventing contamination from escaping from the box. Air flow through the glove boxes is about 5 cfm unless larger quantities are required for heat dissipation. All in-flow air is prefiltered into the box through an absolute filter. In analytical operation where hazards are reduced to the extent that the boxes may be operated without gloves or by removing the glove panels, the standard hood requirement of 100 linear fpm air flow across the opening is required.

The utility room, as previously mentioned, is outside the contaminated zone and has controlled access from the outside; in addition to being used for receiving of materials and chemicals, it contains the air compressor for the building ventilation system and the electrical switch gear for the building electrical service. The utility room is isolated from the second floor by an air lock (see Fig. 3). Entry into the utility room from the contamination zone is via the building corridor and through the controlled access door. Interlocks prevent opening of the access door and the exterior doors simultaneously. The building corridor acts as an air lock between the laboratory containing the radioactive material and the utility room. Ventilation is by a nonfiltered temperature-sensing inlet louver located in the south wall and a like-operated exhaust fan located above the door in the east wall. The exhaust fan operates continuously.

The instrument laboratory (Fig. 2) now contains a Cary spectrophotometer. It is used only in working with natural uranium. When the program is extended to investigations on materials of higher specific activity, it will be moved into laboratory 5.

The counting room is used in support of the operations performed by Analytical Chemistry Division personnel. By nature, the type of operations carried out in the room require an extremely low background. Standard counting equipment is used.

Offices 6, 7, and 8 provide clerical and administrative space in the contamination zone, thus increasing the efficiency of overall laboratory operations.

The remaining facilities, change rooms, offices 1 through 5, and the lunch room are self-explanatory.

The second floor of the isolation laboratory (Figs. 3 and 4) contains the laboratory air conditioning supply and ventilation exhaust, off-gas, vacuum, and glove box ventilation collection and cleanup systems. It is a large, open-bay, noninsulated area, with the exterior building walls and the built-up tar and gravel roof of the building providing the barrier from the atmosphere. Access into the area is from the utility room up the circular stairs located in the southeast corner of the room and through the air lock. The door at the west end of the area is for emergency use only. The area is ventilated by a temperature sensing louver in the west wall and an exhaust fan in the east wall. Both inlet and outlet are filtered and are equipped with dampers to close in the event of an emergency.

In the overall building ventilation plan, the unlimited access administrative area, utility room, and second floor area are operated at atmospheric pressure. The remainder of the building, i.e., the contamination zone, is operated at a pressure negative with respect to these areas, thus providing leakage into the controlled zone at all times. Within the contamination zone itself, there are three additional gradients of pressure differential. The change room, although on a separate exhaust system, is operated at the same pressure as offices 6, 7, and 8, the counting room, and the instrument laboratory. This static pressure is the highest gradient for the zone but less than the atmospheric pressure of the unlimited access area. The adjacent corridor is operated at a greater negative pressure and the laboratories at the maximum negative pressure. This pressure differential scheme ensures flow to the area of highest contamination potential within the controlled access zone.

The supply system for the building air conditioning is also equipped with a filter and a damper which closes in an emergency. With both the air conditioner supply and the second floor ventilation dampers closed and the contaminated zone exhaust system operating, it is possible to maintain a static negative pressure of 0.3 in. water gage on the entire building.

3.2 Process Description

For development programs, laboratory-scale solvent extraction and ion exchange operations usually predominate, but most types of chemical research using normal laboratory-scale equipment are performed at one time or another. In addition to research and development work, special chemical operations involving large quantities of alpha-active material are performed. For example, recently 180 g of Am^{241} was converted from the chloride solution to the dry powered oxide. The complete operation was carried out in a glove box line shielded with a thin lead shield for protection against the weak gamma emission of the Am^{241}. This operation, as are all other such programs, was done on a batch basis, with a specific amount (~30 g) of material being carried through the entire conversion operation before the next batch was started through the process equipment. The operations required and performed in sequence were precipitation of the Am^{241} as the oxalate with oxalic acid; filtration of the precipitate; drying; calcining to oxide in a muffle furnace; and packaging. The batch size used in this specific operation is a factor of 100 greater than the amount that is normally handled in a routine glove box operation. Such operations require special review and approval and adequate steps must be taken to ensure that no activity will be released from the glove box. The process equipment is depicted schematically in Fig. 7.

3.3 Waste Systems

In the actual operations of the Isolation Laboratory alpha-containing solid, liquid, and gaseous wastes are generated.

3.3.1 Solid Wastes

Highly contaminated solid wastes are produced in operations carried out within the glove box; slightly contaminated solids are produced in the laboratory where the glove box is located and in support of actual glove box operations. Typical of high level waste are glove box rubber gloves and plastic transfer bags, paper tissues, glassware, and small pieces of equipment. The safe removal and disposal of these wastes involves transfer from the high-alpha environment inside the glove box by the plastic bag transfer technique, placing the plastic bag in a lard can, and sealing the top of the can. These cans are carefully buried underground.

The low-level waste, consisting of such items as shoe covers, blotting paper, and paper tissues, are placed in a garbage can lined with a plastic bag. When filled, the plastic bag is sealed by tying or taping the top, and the filled bag is disposed of by the same procedure as the high-level wastes. Solid waste discharge per day varies according to operations but averages about 50 lb/day.

3.3.2 Liquid Wastes

Sanitary, process, and radioactive waste solutions are generated routinely in the isolation laboratory. Schematics of the first and second floor liquid waste systems are shown in Figs. 8 and 9.

The sanitary waste system collects and dispenses all waste from the sanitary facilities except the change room showers, which are discharged to the process waste system. The estimated volume discharged per day is 250 gal.

The process waste system handles liquids which generally are nonradioactive, but which can be contaminated by accident. Change room showers, condenser cooling and condensate water from experimental equipment, laboratory bench sinks used for glassware cleanup, washdown solutions entering through the floor drains are potential sources. Process waste is collected in a 2000-gal intermediate holdup tank, which is sampled and discharged to either the process or radioactive chemical waste systems as dictated by the analytical results. The tank is equipped with a level alarm and an overflow which discharges directly into the radioactive waste system. Normal process waste effluent is approximately 250 gal/day.

Two independent waste systems, the high-level and the "hot" chemical, are provided for liquid wastes known to be radioactive. Normal access points for the high-level waste system are the cup sinks in the laboratory bench hoods. The entry points to the "hot" chemical waste system are laboratory bench sinks and the glove box line in laboratory 4. There are no drain outlets in the glove boxes in laboratory 2. All waste solutions accumulated during operation are collected and transferred to a special liquid waste disposal vessel in the northwest corner of laboratory 2; it can be monitored and discharged to the high-level waste system.

The "hot" chemical waste system drains to WC-5, an intermediate 1000-gal stainless steel underground collection tank south of Bldg. 3503. The tank is equipped with a level indicator and a sampling port. At periodic intervals the tank is sampled and analyzed and the contents discharged to either the plant process waste system or the tank "hot" chemical waste. The high-level waste system drains to WC-6, an intermediate stainless steel tank of 500 gal capacity, adjacent to WC-5. This tank is also equipped with level indicator and sampling port. After analysis, the solutions are pumped to tank W-9. "Hot" liquid waste discharged to the combined systems is approximately 25 gal/day.

3.3.3 Gaseous Waste

Figures 3 and 4 are schematics of the gaseous waste processing facilities in the isolation laboratory. Room ventilation air, laboratory vacuum service, chemical off-gas system, glove box ventilation air, and plutonium cells ventilation air are the gaseous wastes generated and routinely processed.

There are five separate zones of ventilation in the Alpha Isolation Laboratory. Of these, the office area and the first floor operating area are air-conditioned systems, and the first floor utility room, first floor emergency corridor, and second floor mechanical equipment area systems are unconditioned. All except the office area system are once-through systems with 100% makeup air. A schematic of the ventilation flow in the building is shown in Fig. 10.

The office area, which includes offices 1 through 5 and the lunch room, is supplied with conditioned air from Chrysler air temperature window units. Each office has a single unit with a makeup capacity of 45 cfm. This corresponds to a recycle of approximately 70%.

The first floor operating area is supplied with conditioned air by a 63-ton McQuay, Inc. model A232 central supply unit located in the second floor mechanical area. The inlet supply is prefiltered by a 2-in.-thick dust stop filter followed by a 12-in.-thick 90% NBS filter. The air is conditioned to a dry bulb temperature of 57.3°F and a wet bulb temperature of 58.8°F before entering the distribution system. Preheated coils in the distribution system ducts raise the temperature to 70°F before discharge. A schematic of the first floor distribution is shown in Fig. 11. The minimum required number of air changes per hour for the operating facilities and the actual number of changes based on the flows shown in Fig. 11 are:

Room	Required Minimum No. of Changes/hr	Calculated No. of Changes/hr
Office 6	6	14.5
Office 7	6	14.5
Office 8	6	14.5
Change room	6	13.0
Instrument lab	10	14.5
Counting room	6	14.5
Laboratories 1 through 5	10	18.2
Corridor	6	14.7

As shown, air is introduced into the offices, change room, instrument laboratory, counting rooms, and laboratories. The air flows into the corridor from the offices, instrument laboratory, and counting rooms through louvers in the personnel access doors. This air is exhausted from the corridor through grills in the suspended ceiling, which discharge into the laboratory room ventilation exhaust system for final cleanup. The change room air is exhausted into a separate system located in the mechanical equipment area. It is prefiltered through a 12-in.-thick 90% NBS filter followed by a 12-in.-thick 99.97% absolute filter before local discharge at the roof of the building. The ventilation air for laboratories 1 through 5 is distributed into each room through a diffuser centrally located in the suspended ceiling. Either optimumly located exhaust grills (laboratories 2, 4, and 5) or laboratory bench hoods (laboratories 1 and 3) are utilized for exhausting the air to the mechanical equipment area for final cleaning. Five separate systems (Fig. 3) are utilized. These are arranged so that a single laboratory is tied into a minimum of two separate systems. This feature ensures continuous ventilation exhaust. Final cleaning of the ventilation air is through a 12-in.-thick 90% NBS filter followed by a 12-in.-thick 99.97% absolute filter before local discharge at the building roof level. The exhaust systems are tied into the plant emergency power supply system. The total capacity of the system is adequate to maintain a negative pressure on the whole building when all supply air is cut off. Dampers at the supply entry to the operating area and all other ventilation systems actuated by the alarm on the room or area air monitors cut off the inlet air in an emergency.

The utility room ventilation capacity of 10,000 cfm is based on the heat load dissipation from the equipment in the area rather than any personnel requirements. As stated previously, the utility room is an isolated nonoperating room located outside the contamination zone but with controlled access. Neither the inlet nor exhaust air is filtered or treated. The system consists of a temperature-operated inlet louver in the south wall of the building. A second temperature-operated louver and associated exhaust fan are located in the east wall above the double-access doors. The fan operates continuously. To guard against the possibility of spread of air-borne activity from the adjoining areas in the contaminated zone, the personnel access door from the corridor, the equipment hatch from the mechanical equipment area, and the exhaust fan and double-access doors are interlocked.

The once-through ventilation system of the mechanical equipment area uses the same mechanical principle of a continuously operating exhaust fan and temperature-operated louver on the utility room system. Ventilation requirements here, too, are based on heat load dissipation rather than personnel requirements. However, this nonoperating area is located inside the contamination zone; therefore supply air and exhaust air require filtration. The inlet supply air is prefiltered through a 2-in. dust filter followed by a 12-in.-thick 90% NBS filter. The exhaust before local discharge at the building is prefiltered through a 12-in.-thick 90% NBS filter followed by a 12-in.-thick 99.97% absolute filter. Both the inlet supply and exhaust are dampered. Under emergency conditions, the mechanical equipment area ventilation air is discharged by means of a dampered by-pass into the laboratory room cleaning system upstream from the filter.

The emergency corridor ventilation system of 1000 cfm is based on a minimum requirement of 6 air changes per hour. The system also depends on a continuously operating exhaust fan and temperature-controlled inlet and exhaust louver. The inlet supply over the emergency door at the west end of the corridor is filtered through a 2-in. dust stop filter followed by a 12-in.-thick 90% NBS filter. The exhaust is filtered through a 12-in.-thick 90% NBS prefilter followed by a 99.97% absolute filter before local discharge. Both the inlet supply and the exhaust are equipped with dampers which close during an emergency. In an emergency the corridor is held under static conditions with air leakage into the laboratories.

The building off-gas service is used exclusively in the "cold" laboratories for chemical operations in which gas evolution is a problem. The service outlets are on the bench hoods. Local cleanup of the gas streams through caustic scrubbers designed as part of the equipment is standard practice. The off-gas stream is further cleaned by a liquid trap and two 12-in.-thick 99.97% absolute filters in series; it is discharged to the atmosphere at the roof level of the building. Average usage per day is approximately 5 cfm, although the design capacity for the system is 280 cfm at 1.8 in. Hg.

One-half-inch lines in the laboratory service racks provide vacuum service to both the alpha and the "cold" laboratories. From the alpha laboratories potentially contaminated air in the vacuum system passes to a liquid trap and a 12-in.-thick 99.97% absolute filter located in the first floor pipe service chase; this is followed by a second liquid trap and a 12-in.-thick 99.97% absolute filter located in the mechanical equipment area (Fig. 4). Vacuum effluent from the "cold" laboratories discharges directly into the cleanup system located in the mechanical equipment area upstream from the liquid trap without prior cleaning. After final filtration the clean effluent discharges to the glove box ventilation header downstream from the final filter. Vacuum is maintained in the system by a Nash Hytor pump; water coolant from this pump is recirculated through a heat exchanger. The loop surge tank is sampled daily, and the entire contents of the loop are drained to the process waste system and replenished when the alpha activity of the water reached 10^3 counts/ml. The design capacity of the vacuum system is 90 cfm at 22 in. Hg.

There are two glove box ventilation systems in the Alpha Isolation Laboratory. The primary system (Fig. 12) is used for the laboratory No. 2 glove boxes, in which multicurie quantities of alpha activity are handled. Air flows through the glove boxes at a standard rate of 5 cfm. The air enters the box from the laboratory room through a 99.97% absolute filter. Air leaving the box is filtered in the box through a FG-50 prefilter followed by a 12-in.-thick 99.97% absolute filter at the exit from each box. The glove box air is collected in the building and further cleaned by a second 12-in.-thick 99.97% absolute filter located in the mechanical equipment area (Fig. 4). The clean air is discharged to the plant off-gas system, which at Bldg. 3508 supplies a vacuum of approximately 25 in. water gage, for further treatment (scrubber, heater, roughing and absolute filters) and disposal at the 3039 stack. The ventilation system is so designed that the glove boxes will operate at a constant -0.35 in. water gage pressure at flows from 5 to 30 cfm. A vacuum dial indicator equipped with an alarm which actuates if the box pressure falls below -0.10 in. water gage pressure is standard equipment on all glove boxes. A surge tank located upstream from the final absolute filter is equipped with a control valve which reduces and maintains a constant pressure on the system. The valve is designed to fail closed. A solenoid-operated valve is located in parallel to the control valve and is actuated upon failure of the control valve. It is designed to maintain -0.35 in. at 5 cfm flow. The capacity of the system is ~250 cfm. Backflow preventers are used on all boxes ahead of the inlet filter to prevent escape of activity into the laboratory if the box should become pressurized. During shutdown of the plant off-gas system a hand-operated valve located ahead of the final absolute filter reroutes the box ventilation exhaust into the Bldg. 3508 off-gas system upstream from the absolute filters. This alternative route ensures continuous box ventilation exhaust service at all times.

The secondary glove box ventilation system is used for ventilating the 16 glove boxes and 6 glove box hoods in laboratory No. 4. Flow through the glove boxes is the standard 5 cfm, and the glove box hoods, 200 cfm each. The total capacity of the system is 1280 cfm. Air is introduced into the glove boxes through an absolute filter. A backflow preventer precedes the filter to prevent blowback into the laboratory in case the box becomes pressurized. Air leaving the box is filtered in the box through an FG-50 filter followed by a 12-in.-thick 99.97% absolute filter located at the exit from the box. Air enters the glove box hoods unfiltered through the glove ports. The 200 cfm flow corresponds to ~100 linear fpm flow velocity, the design limit for laboratory hoods. The exhaust air is prefiltered through an FG-50 filter in the box and a 12-in.-thick 99.97% absolute filter at the exit from the box.

The glove box air is discharged to a plenum equipped with a control valve which maintains a constant -0.35 in. water gage pressure on the box. No ΔP control is attempted on the glove box hoods. Their exhaust enters the glove box exhaust system downstream from the control plenum. The combined exhausts are filtered through a 12-in.-thick 90% NBS filter followed by a 12-in.-thick 99.97% absolute filter before discharge to the atmosphere at the roof level of the building.

The plutonium cells in laboratory 5 have their own ventilation system. Air is introduced into the cells from the laboratory through two 8 x 8 x 2-in.-thick 99.97% absolute filters set up in parallel. Exhaust air is filtered in the cell through a 99.97% absolute filter. The independent exhausts from the five cells are collected and further cleaned through a 12-in.-thick 99.97% absolute filter in the mechanical equipment room (Fig. 4). The clean air is discharged from the building at roof level. Each cell is equipped with manually operated dampers which regulate the flow through the cells. The normal flow based on 10 air changes per hour is 50 cfm per cell. However, sufficient capacity exists in the system to operate the cells at approximately twice the flow rate. Storage vessels in the cell, such as the liquid solution carrier containing approximately 2000 curies of nonvolatile fission products and trace amounts of americium and curium, are separately vented through absolute filters to the glove box exhaust ventilation system.

Continuous air sampling monitors will be installed on all gas effluent streams from the Alpha Isolation Laboratory downstream from the final cleanup point as soon as they are developed by the ORNL Instrument Department.

4.0 HAZARD DESCRIPTION

4.1 Radiation

Alpha radiation is the predominant type in the Alpha Isolation Laboratory operations. Periodically, however, associated gamma and neutron radiations are also present. Standard glove box containment and operating techniques are applied in working with pure alpha-emitting materials. When gamma and neutron radiations are associated with the alpha radiation, adequate steps are taken to shield the box for maximum operator protection.

The quantity of radioactive material handled in the laboratory varies. Most analytical chemistry operations are performed on diluted samples or samples of relatively low hazard potential. When the sample concentration is below 1 mg of plutonium, the operations are performed in glove box hoods, i.e., glove boxes with the gloves removed. Operations in which concentrations exceed 1 mg of plutonium must be performed in glove boxes. The amounts of material handled in the Chemical Technology Division programs vary from the milligram tracer quantities used in the process development work to the hundred gram batch quantities processed in the special isolation and purification programs. All operations without exception are carried out in glove boxes. The upper limit of material that can be stored or handled in the Alpha Isolation Laboratory without a formal Radiation Safety Review is 45 mg Am^{241}, 1 g Pu^{239}, and 30 g U^{233}. The approved limits for Am^{241} and U^{233} processing are 30 g and 250 g batches, respectively.

Continuous air sampling and monitoring alpha, beta, and gamma instruments are located in laboratories 2 and 4, and a stationary air alpha sampling unit is located in the second floor utility room. The stationary unit will be replaced by a continuous type now on order. These units are pre-set to alarm when the alpha air-borne activity level reaches the mpc level and to automatically actuate dampers and put the building on emergency operating status when the air-borne level reaches 10 times the mpc. A stationary beta-gamma air sampling unit is located in the intermediate corridor between the laboratories and change room. Portable gas-flow alpha survey meters are used to monitor glove box operations in the laboratory and to monitor personnel before exit from the laboratory and in the change room as a final check before leaving the contamination zone. Daily smear counts of the whole laboratory are standard procedure for further contamination control.

4.2 Criticality

Generally, the quantity of alpha-emitting materials being isolated is sufficiently small to present no criticality hazard. If programs are extended and criticality must be observed, batch control will be followed. The following batch limits have been set for the Alpha Isolation Laboratory:

Isotope	Batch Size	Limit in Bldg.
U^{233}	250 g	350 g
Pu^{239}	250 g	350 g
Am^{241}	No criticality problem	No criticality problem

4.3 Chemicals

The type of chemicals and the quantity consumed vary from program to program and therefore an average consumption over an extended period is hard to predict. The best approximation based on the present program is:

Chemical	Quantity Consumed/day
HNO_3	500 cc of 15 M
HCl	1000 cc of 12 M
$Al(NO_3)_3$	2000 g
$LiNO_3$	500 g
LiCl	1000 g
LiOH	100 g
TBP	1000 cc of 100%
Amsco 125-82	1000 cc
Mono-2-ethylhexyl phosphoric acid	400 cc
Xylene	1600 cc

4.4 Fire and Explosion

Solvent extraction operations associated with the Alpha Isolation Laboratory development programs require extraction agents dissolved in organic solvents. Currently the HNO_3-TBP-Amsco and the HCl-mono-2-ethylhexyl phosphoric acid-xylene systems are being developed. In both systems the Amsco and the xylene diluents, because of their low flash points, are potential fire hazards. The properties of these two solvents are:

	Amsco 125-82	o-Xylene
Closed cup flash point, ^{o}F	128	63
Explosive limits in air, %	1.1-6.1	1.0
Energy released on combustion, Btu/lb	19,000	18,500
Total energy release to glove box, Btu	62,700	72,100

During glove box operations the spent solvent is collected and stored in the box until the end of the run. Approximately 2 liters collects. Fortunately there are no operations in the multicurie processing work in which solvents or other combustible materials are used.

The possibility of an explosion in the glove box operations appears remote. None of the operations involves release of hydrogen except that quantity which builds up by the radiolytic decomposition of water. If the box ventilation system should fail for 24 hours and the gas continue to build up in the glove box for that period with the given amounts of U^{233} and Am^{241}, the hydrogen concentration would be:

	U^{233}	Am^{241}
Quantity of material in box, g	250	30
Volume of H_2 gas evolved, cc/day	4	1410
Volume of box, cc	4.2×10^5	4.52×10^5
Final concentration, cc H_2/cc air	8.87×10^{-6}	3.1×10^{-3}

These values are well below the explosive limit of 4.1 volume % for hydrogen gas.

If the same assumption is made for a glove box in which 2 liters of solvent is stored, air explosion due to the accumulated vapors in the box is not probable since the auto-ignition temperatures for Amsco and xylene are 490 and 924^{o}F, respectively. Of course, if there is a heat source or spark present, the possibility is increased, particularly in the case of xylene which has a closed cup flash point of 63^{o}F.

In the analytical chemistry operations perchloric acid fumings are done routinely. Procedure control is used to make this operation safe. At least one pre-nitric acid oxidation fuming step is required to minimize the potentially violent reaction of perchloric acid with organic matter. The buildup of perchloric acid by condensation of the perchloric acid vapor fumes is prevented by passing the vapor stream through a caustic scrubber.

In addition to using the multicurie glove box, which is designed for maximum containment in the event of a fire or explosion, the following practices have been established to eliminate as completely as possible the probability of a glove box fire or explosion:

1. During all solvent extraction operations an inert gas purge is used on the glove box ventilation system. An oxygen analyzer regulates the flow and keeps the oxygen content of the box below 2 vol %. In normal glove box operations the purge system is used as a medium for extinguishing glove box fires. The system is actuated by a temperature-sensing control mounted in the box.

2. Highly volatile solvents such as xylene are kept at temperatures well below the flash point by localized cooling.

3. Explosion-proof electrical equipment is used where possible.

4. All glove box interior surfaces are painted with noncombustible phenoline 304 paint.

5. In operations where large amounts of heat are generated, localized cooling is built into the equipment to prevent heat buildup and temperature rise in the box.

Within the building itself hose cabinets on both the first and second floors and portable CO_2 extinguishers in the corridor outside the laboratories can be used for extinguishing fires outside a glove box. The building at present is not equipped with a sprinkler system, but such a system is to be installed when funds become available.

4.5 Maximum Credible Accident

In establishing the maximum credible accident potential for the Alpha Isolation Laboratory release of activity by fire and/or explosion under the following conditions was considered:

1. In glove box development program operations.
2. During glove box multicurie alpha purification programs.
3. From material stored in the building itself.

This last category includes 180 g of AmO_2 and 15 liters of solution containing 10 curies of Cm^{242}, 58 curies of Am^{241}, and approximately 2000 curies of non-volatile mixed fission products. Both the AmO_2 and the mixed fission product solution are stored in primary shielded containers located in laboratory No. 5 plutonium cells. It was concluded that the maximum credible accident potential existed in the multicurie alpha purification operations, where only a single line of containment, i.e., the glove box, afforded the operator protection from lethal quantities of alpha-emitting material.

In establishing the models for the hazard evaluation the recently completed Am^{241} program and the future U^{233} program were selected. In these special programs 30-g batches of Am^{241} and 250-g batches of U^{233} are put through the process line. Both were analyzed according to the standard model outlined in volume 1 of this report as well as a special case in which the following assumptions were made:

1. The dry box was considered as the process vessel, the laboratory room as a cell, and the area surrounding the laboratory room, in this case the emergency corridor, as the secondary containment.

2. The operator would receive a maximum integrated dose in 15 sec, the time required to properly put on a respirator, instead of 2 min.

3. The particles in suspension contain 0.3 mg of AmO_2 or UO_3 per cubic meter instead of 10 mg/m^3; 0.3 mg/m^3 is the mean of the range of data for UO_3 suspensions.

The calculations are summarized in the following table:

	Standard		Special	
	U^{233}	Am^{241}	U^{233}	Am^{241}
Vessel Off-gas Release				
Total amount, curies	-	-	6.4×10^{-9}	1.73×10^{-4}
Max. downwind integrated dose, rem	-	-	<0.001	<0.001
Distance downwind of dose, m	-	-	150	150
Cell Off-gas Release				
Total amount, curies	6.4×10^{-8}	1.73×10^{-3}	-	-
Max. downwind integrated dose, rem	<0.001	0.0046	-	-
Distance downwind of dose, m	150	150	-	-
Release into Secondary Containment Zone				
Total amount, curies	1.5×10^{-3}	4.0	4.5×10^{-5}	0.12
Concentration, curies/m^3	1.0×10^{-5}	2.7×10^{-2}	3.0×10^{-7}	8.1×10^{-4}
Dose to building personnel, rem	10*	5.4×10^{5}*	3.6×10^{-2}**	2.0×10^{3}**
Release from Secondary Containment Zone				
(Assuming ventilation system does not fail)				
Total amount, curies	2.4×10^{-5}	6.5×10^{-2}	6.3×10^{-7}	1.7×10^{-3}
Max. downwind integrated dose, rem	<0.001	1.87	<0.001	0.05

*2-min dose. **15-sec dose.

	Standard U^{233}	Standard Am^{241}	Special U^{233}	Special Am^{241}
Distance downwind of dose, m	150	150	150	150
Ground fallout at 20 meters, curies/m^2	9.5×10^{-11}	2.4×10^{-7}	2.5×10^{-12}	6.3×10^{-9}
Distance downwind to which ground would be contaminated to hazardous level, m	0	6	0	0
Distance downwind to which ground must be decontaminated, m	0	45	0	8
<u>Release from Secondary Containment Zone</u>				
(Assuming ventilation system fails)				
Total amount, curies	6.0×10^{-5}	1.53	7.5×10^{-6}	1.9×10^{-2}
Max. downwind integrated dose, rem	<0.001	43.0	<0.001	0.54
Distance downwind of dose, m	150	150	150	150
Ground fallout at 20 meters, curies/m^2	2.2×10^{-10}	5.6×10^{-6}	2.7×10^{-11}	6.9×10^{-8}
Distance downwind to which ground would be contaminated to hazardours level, m	0	46	0	5
Distance downwind to which ground must be decontaminated, m	0	250	0	24

5.0 OPERATING PHILOSOPHY

The Isolation Laboratory, as shown in Fig. 2, is subdivided into an unlimited-access and controlled-access contamination area. Normal entry into the building is via the unlimited-access administrative area at the southwest end of the laboratory. Access into the contamination area is from the administrative area through the change room. Hence the change room acts as an intermediate area beyond which special clothing must be worn, and, conversely, a monitoring check point for personnel exiting from the contamination area. The utility room is an area into which unlimited access is permissible from the exterior of the building, but access from the controlled area is regulated by personnel monitoring.

Clothing requirements for personnel working in the contamination zones are coveralls, shoe covers, and rubber gloves taped to the coverall sleeves for containment. Additional requirements include safety glasses, pocket meters, and an extra film badge and a respirator, either worn or carried, as dictated by the operation. Visitors to the controlled area are required to wear a laboratory coat, shoe covers, and safety glasses.

Equipment, particularly inexpensive laboratory glassware, is disposed of to "hot" waste in preference to decontaminating it. In-box equipment is only partially decontaminated as long as it is usable. It is never removed from the box in the semicontaminated state until it is ready for disposal.

If the laboratory room or glove box exteriors become contaminated, they are scrubbed with detergents and/or dilute acid. If the contamination is slight, normal controlled-area clothing is used in performing these operations. For higher levels, a respirator is required; and for very high levels, plastic suits with an external air supply are used.

At the conclusion of a normal work period, or a decontamination operation, all personnel are required to shower and to be extensively monitored by a Health Physics surveyor.

6.0 EMERGENCY PROCEDURE

In the event of an emergency, personnel are instructed to consider both personnel safety and containment of hazardous materials at all times, and only those actions consistent with these two principles are to be carried out.

Personnel evacuated from the building are to assemble at the Metal Recovery Plant. Here they will be monitored by Health Physics. If necessary, the Metal Recovery change room can be used for personnel decontamination. Since the Metal Recovery Building and the Isolation Building are located in the same limited area enclosure, personnel will not spread activity in areas normally traversed by the rest of the ORNL personnel.

An emergency squad has been organized for Bldg. 3508 to aid in personnel evacuation and to serve as sentries to prevent others from entering the building during the emergency.

Since the building serves as secondary containment, the exhaust is filtered through absolute filters. In case of an accidental release of activity in the building, the building exhaust monitors make certain that no activity escapes from the building. If a filter has failed and an activity leak is detected through one of the filters, this exhaust fan is immediately turned off and the remaining exhaust fans carry the load.

DISTRIBUTION

1-50. F. L. Culler
51. T. A. Arehart
52. R. D. Baybarz
53. R. E. Blanco
54. B. F. Bottenfield
55. J. C. Bresee
56. K. B. Brown
57. F. R. Bruce
58. T. J. Burnett
59. R. L. Clark
60. J. H. Cooper
61. L. T. Corbin
62. W. K. Eister
63. D. E. Ferguson
64. E. J. Frederick
65. H. E. Goeller
66. A. T. Gresky
67. C. E. Guthrie
68. T. W. Hungerford
69. F. Kertesz
70. M. T. Kelley
71. W. H. Lewis
72. R. E. Leuze
73. H. F. McDuffie
74. K. Z. Morgan
75. W. L. Morgan
76. E. J. Murphy
77. A. F. Rupp
78. J. A. Swartout
79. W. E. Unger
80. A. M. Weinberg
81. M. E. Whatley
82. C. E. Winters
83. ORNL-RC
84-100. Laboratory Records