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BUILDING 4507 OPERATIONS MANUAL

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1.0 INTRODUCTION

This manual was written to familiarize all individuals having work assignments at Building 4507 with the safe operations and emergency procedures developed for this type of facility. A copy of this manual will be supplied to each person with a current work assignment at the facility; additional copies are available to others on request.

It was intended to consolidate all information pertinent to Building 4507 operations under one cover; however, the manual may require additions and revisions in the future.

2.0 SUMMARY

This manual contains information intended to aid individuals with current or future work assignments at Building 4507, the High Level Chemical Development Facility. The information presented herein is expected to promote safe, efficient operations at this facility; strict adherence to all procedures and regulations should prevent excessive exposure of personnel to radiation and contamination or significant release of activity from the building.

Included in the manual are descriptions of the building and attendant service features such as liquid and gaseous waste systems and the building airflow system. Various operating procedures are discussed which include process operations, methods of handling fuel specimens, housekeeping, new chemical flowsheets, sealing and checkout of "hot" cells, installation of experimental equipment, "hot" cell entry, equipment and cell decontamination, and disposal of radioactive materials.

Radiation control is maintained by Health Physics zoning practices and radiation monitoring, and by emergency containment features built into the facility.

2.1 Zoning and Personnel Protection

Regulated Zone - Entire building and loading area at west end.
Either street or clean contamination zone clothing may be worn except in areas designated as contamination zones.
Pocket dosimeters must be worn by all personnel working in the building.

Contamination Zones - Cells 1, 2, 3, and 4, Penthouse, other areas so designated.
Contamination zone clothing required as specified at entrance to zone or on radiation work permit.
Personnel must be monitored for contamination on leaving zone.

Radiation Zone - Cells 1, 2, 3, and 4, other areas so designated. A radiation work permit or extended radiation work permit is required for entry into radiation zones.

Special emphasis is placed on emergency procedures and procedures involving administrative control.

2.2 Administrative Control of Building

Approval of the building supervisor or his alternate is required to:

(1) Open penthouse gantry crane door.
(2) Open monorail door in charging area.
(3) Change settings on cell exhaust dampers.
(4) Open rear plug doors to "hot" cells.
(5) Change settings on valves in valve pit or radioactive waste storage pit.
(6) Perform maintenance on lines interconnecting between cells; i.e., waste, vessel off-gas, etc.

The transfer drawers are not to be used for removing materials from the cells. They are used only to insert nonradioactive materials, tools, small equipment, etc., into the cells.

2.3 Emergency Procedures

The type and location of all alarms and the action required are shown in Table 1. If the radiation monitors or evacuation horn sound, evacuate and actuate emergency switch to contain building. Assemble in the covered passageway between 4500 and 4505.

Table 1. Alarms for Building 4507

Location	Type	Sound	Lights	Action to Take
Penthouse	2 ea Q-2240 CAM	Intermittent Bell Continuous Bell Continuous Bell	Flash White Contin. Red Contin. White	Evacuate and Contain. Evacuate and Contain. Check inst., if zero scale reading call HP.
Charging Area	2 ea Q-2240 CAM	As Above	As Above	Same as for CAM in penthouse.
	4 ea Q-1154 "Monitron"	Continuous Bell	Red and Blue	Switch to high level scale. If bell continues, evacuate bldg, call HP and find source of radioactivity.
Change Room	1 ea Q-1257 "Quintector"	Continuous Bell	None	Check self with α and β-γ survey meters.
Operating Area	1 ea Q-1154 "Monitron"	Continuous Bell	Red and Blue	Same as for monitron in charging area.
	1 ea Q-2240 CAM	As Above	As Above	Same as for CAM in penthouse.
	Cell 1 Annunciators	Buzzer	Red	Acknowledge, Correct, Reset.
	D/P Annunciator Panel	Buzzer	Red	Acknowledge, Correct, Reset.
	Containment Panel	Stroking Bell	Red	Reset and Correct or Contain.
	HP Instrument Panel including process waste monitor		Green	Normal Operation.
			White	Call HP - Inst. failure.
		Buzzer	Amber	Health Physics level.
		Buzzer	Red	Evacuate and Contain.
	Fluorine Leak	Stroking Bell	Green	Notify Volatility Grp, Cell 4
Entire Bldg.	Fire Alarm Horn	Horn	None	Evacuate and Contain.
	Containment Evac. Horn	Horn	None	Evacuate and Contain.

3.0 PLANT AND PROCESS DESCRIPTION

3.1 Description of Building 4507

Building 4507 is a brick building with a new penthouse structure constructed from insulated sheet metal. Vestibule personnel entrances are provided, and the building is sealed against leaks so as to be able to maintain -0.3 in. H_2O pressure with respect to atmosphere. The building and penthouse provide secondary containment for radioactive materials handled. Primary containment is provided by the cell block, which is 44 ft long, 19 ft 6 in. wide, and 22 ft 3 in. high and contains four cells. Each cell has a usable volume that is 10 ft long, 6 ft wide, and 11 ft high, separated from one another by 4-ft-thick concrete walls. The rear wall of the cell block is 5 ft 6 in. thick and the front wall, which has four dense lead-glass windows (one for each cell), is 4-ft-thick special barytes concrete. All openings into the cell are sealed against extraneous leaks, allowing air access to the cell only as planned via the air inlet duct in the rear door (Figs. 1 and 2).

A 6 x 6-ft opening in the rear of each cell is closed by a concrete door that rolls on wheels and track. Access is available to the top of each cell through a 4 x 6-ft opening by removing concrete plugs.

Each cell has two 12-in.-dia sleeves in the operating face for a pair of Model 8 manipulators. Various other openings, ranging in size from the 12-in.-dia opening required for the manipulator to 2 in., are provided to accommodate pipe, tubing, electrical conduit, etc. Specially designed openings are used to admit fuel to and withdraw samples from the cells.

3.2 Process Description

Building 4507 is used for flowsheet development in the Power Reactor Fuel Processing, TRU, Wastes Treatment, and Fluoride Volatility Programs. Cells 1, 2, and 3 are assigned to work in aqueous processing systems, and cell 4 is assigned to fluoride volatility work. Cell 1 is of primary interest because of probable hazards arising from chemical processing of fissionable and radioactive isotopes.

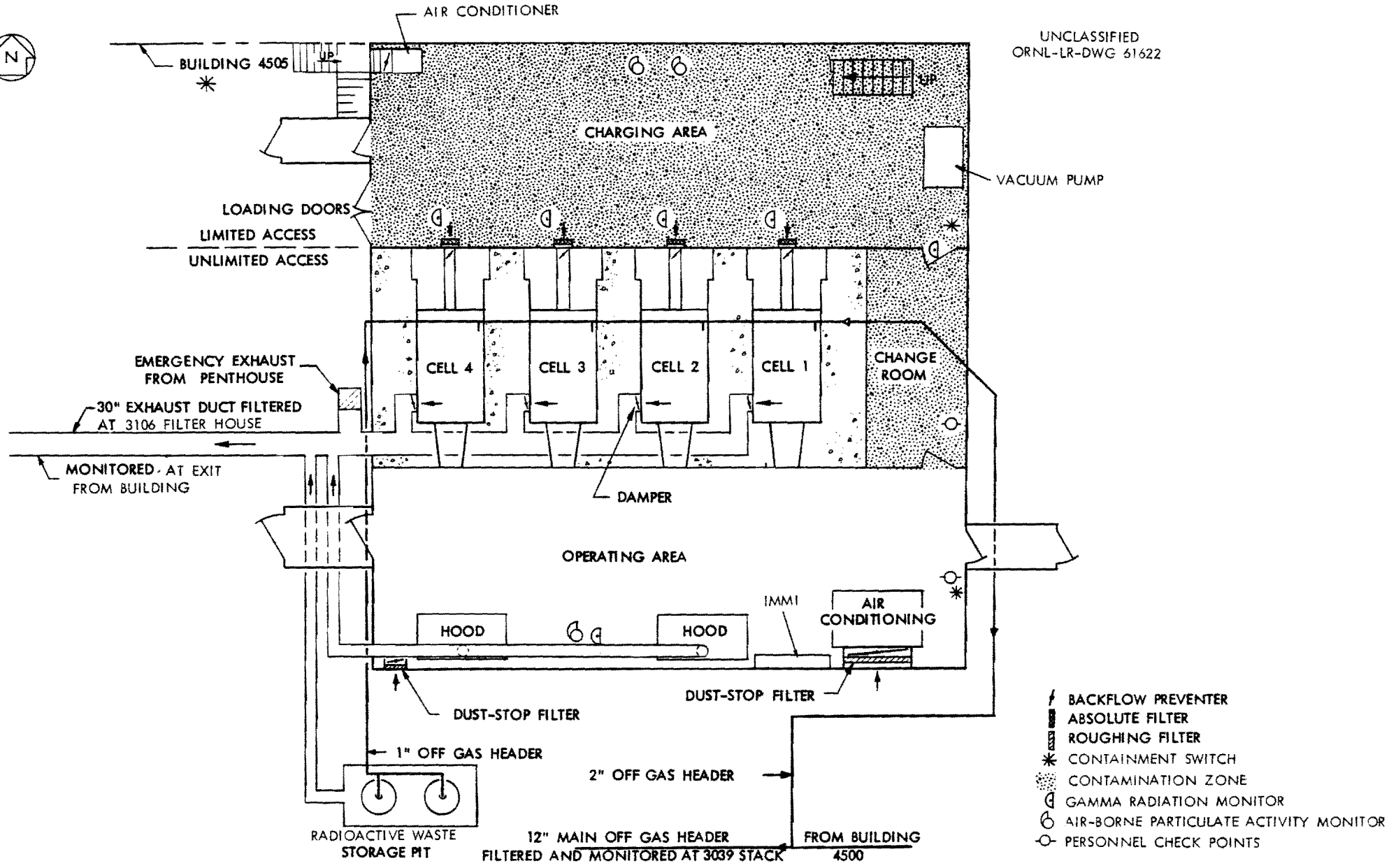

FIG. 1 BUILDING 4507 FIRST FLOOR PLAN VENTILATION SCHEMATIC

Scale ~ 1/8" = 1'-0"

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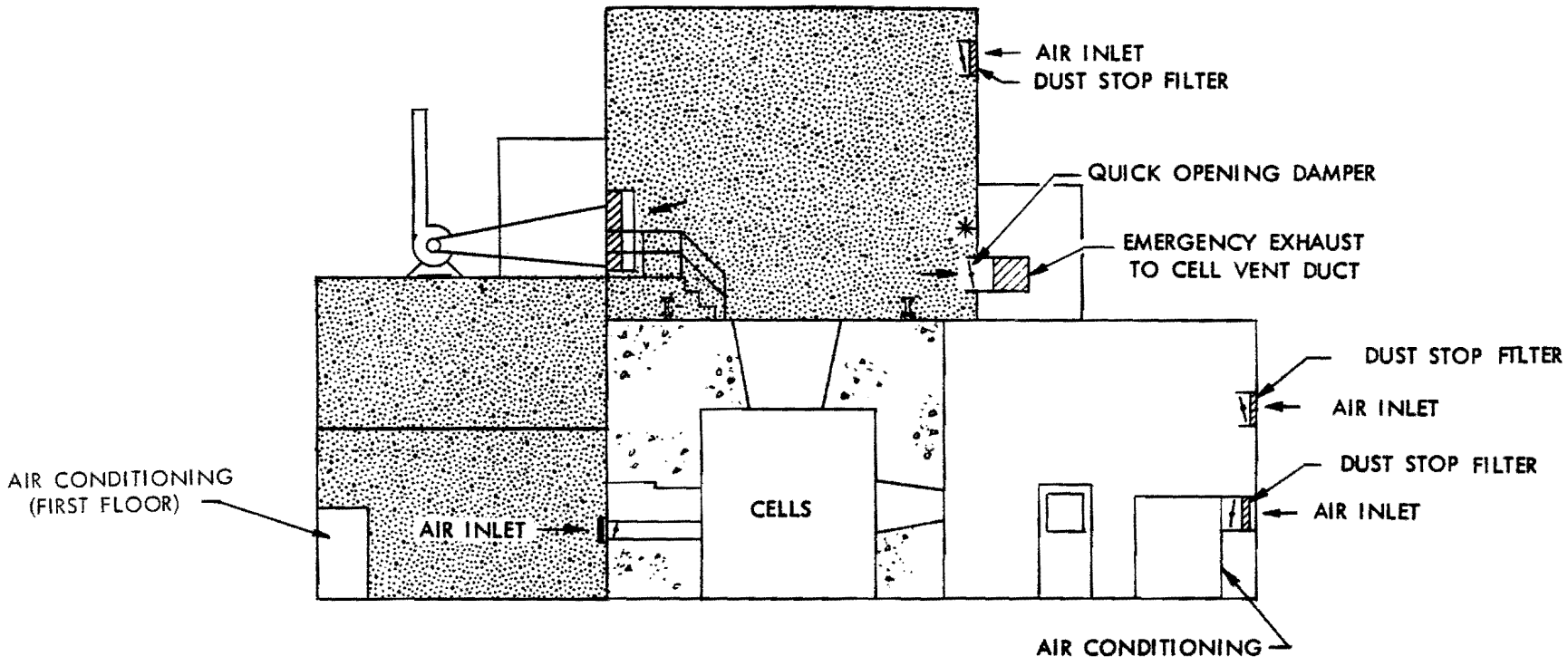

FIG. 2 BUILDING 4507 SECTION VIEW VENTILATION SCHEMATIC

Scale ~ 1/8" = 1'-0"

BACKFLOW PREVENTER
ABSOLUTE FILTER
ROUGHING FILTER
CONTAINMENT SWITCH
CONTAMINATION ZONE

The IMMI (Intermediate-scale mixer-settler) facility in cell 1 is permanently installed and designed for experimental work in processes that use sulfuric acid or caustic decladding agents and a nitric acid core dissolvent. It is designed for semicontinuous processing at throughput rates that vary from 50 to 200 liters per 24 hr. Type 347 stainless steel and Carpenter 20 were the principal materials of construction employed; unit shielding was used in the design to permit limited direct maintenance, and extensive use of instrumentation facilitates remote operation of the equipment.

The nonpermanent equipment used in cells 2 and 3 is smaller than that of cell 1, which correspondingly limits the degree of radiation and contamination hazard. Cell 2 contains "2-liter scale" glass equipment for Head-end processes such as Sulfex and Zirflex. Feed prepared by these processes from UO_2 or ThO_2 fuel specimens clad in stainless steel or Zircaloy is processed through one cycle of solvent extraction using miniature mixer-settlers.

Cell 3 will contain the TRU glove box mockup which in turn contains small-scale glass equipment for feed preparation and ion exchange. Flowsheets developed for isolation and purification of the higher transuranic elements will be evaluated.

Cell 4 is equipped for experiments on the Fused Salt Fluoride Volatility Process now being investigated for uranium-zirconium alloy fuels. Nickel, Inconel, and stainless steel are the principal materials of construction.

3.3 Waste System Description

Gaseous Waste Systems. Building 4507 has a vessel off-gas system, a cell ventilation system, and two forced air exhausters, one in the change room and one in the new penthouse. Any vacuum requirements in the experiments are met by water-operated aspirators where possible. Also available for use are small, locally installed vacuum pumps or a central one for the whole building, both of which are provided with liquid-entrainment traps and filters for removing particulates. Small vacuum pumps discharge into the vessel off-gas system; the central vacuum pump discharges into the cell ventilation system.

Cell Ventilation System. A maximum of 1500 scfm may be withdrawn from each cell through a 16 x 24-in. vent at its base which connects to a 30-in.-dia header leading to the 3039 stack. Each vent is equipped with a damper which may be manually adjusted to provide 1 in. H_2O negative pressure inside the sealed cell. Air in the cell is continuously replaced by air from the secondary containment area through special ducts fitted with absolute filters, dust stop filters, and backflow preventers located in the rear plug doors.

The cell exhaust vents and header are not equipped with filters; rather, the combined cell ventilation air from Buildings 4501, 4505, and 4507 is filtered for radioactive particulate removal before release to the stack at Building 3106. The pressure drop across the filter is to be measured, and the exhaust air monitored for radioactivity.

Alarm instruments for measuring air pressure in each cell are installed. All indicating instruments and alarms associated with the measurement of pressure and radioactivity in the cell ventilating system are located in the operating area with provision for installing duplicate recording instruments in the corridor connecting Buildings 4507 and 4500 at a future date.

Vessel Off-gas System. A 2-in. stainless steel header provides vessel off-gas service for all four cells. Each cell must provide its own scrubber through which the vessel off-gas must pass before entering the header. The vessel off-gas system is instrumented to sound an alarm when the relative pressure in the header increases over the desired 2 in. of water, negative. Normal gas flow in the header is estimated as less than 10 scfm.

The 2-in. header emerges from the east side of Building 4507 to connect with a main 12-in. header from Building 4500. This line goes to the 3039 stack area, where the vessel off-gas goes through a Cottrell precipitator (soon to be bypassed for the new caustic scrubber installation), is filtered and monitored, and is then discharged up the stack.

Building Air System. As a further control over spread of contamination, all building air is filtered. Incoming air passes through conventional dust-stop filters; air ducts into the "hot" cells from the charging area are provided with backflow preventers, absolute and dust-stop filters. This arrangement provides a block against the discharge of airborne activity if a pressurization or explosion should occur within the sealed cell. Exhaust air passes through absolute filters provided on the change room exhauster and the penthouse exhaust fan. If a release of activity occurs in the penthouse, airborne activity should be trapped on the absolute filters to prevent further release to outside.

Liquid Waste Systems. There are three liquid waste systems serving Building 4507 (Fig. 3): (1) the high level radioactive waste system, (2) the radioactive waste collection and storage pit, and (3) the process cooling water waste system. Normal liquid radioactive wastes are collected by a 2-in. header which leaves the east side of Building 4507, and then turns south to connect with the 4-in. header that ties Building 4500 directly to the Liquid Radioactive Waste Tank Farm. Special radioactive wastes may be diverted to Metal Waste Tank WC-14 by setting valves in a pit outside the building. Process waste water is monitored for radioactivity in the Building 4505 cold tunnel before it connects with the main discharge header in Building 4505. Beta-gamma radiation is continuously monitored in a recirculating sampler. When the radiation exceeds 75% of low scale in the sampler, an alarm is actuated on the central panel board in the operating area. Thus, building operators are alerted that an excessive amount of activity is being released to the process waste disposal system. Building operators then determine the source of contamination and eliminate it as rapidly as possible.

The radioactive waste storage pit south of Building 4507 is designed to store a maximum 1000 gal. of radioactive waste solution accumulated from the Pu-Al alloy process operation in Cell 1. This facility, shielded to handle ~250,000 curies of mixed fission products, is treated as if it were a "hot" cell. The pit is constructed of poured, steel-reinforced

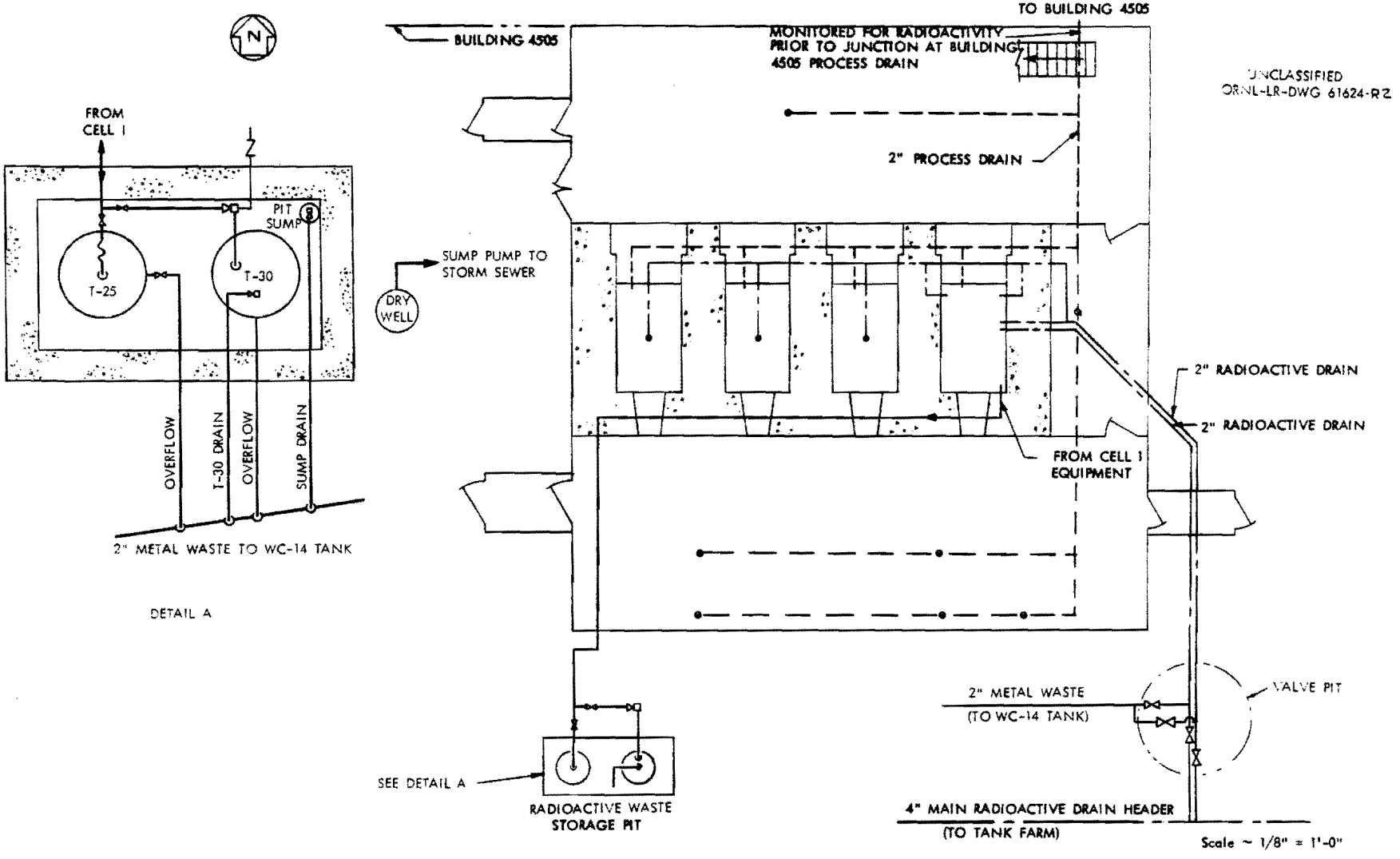

FIG. 3 BUILDING 4507 FIRST FLOOR PLAN DRAIN SYSTEMS SCHEMATIC

concrete with walls and base 12 in. thick. The pit is lined with stainless steel and equipped with a sump and steam jet connection to the adjacent 2-in. metal waste header leading to WC-14. Thus, if the 1000 gal. storage tank or connections leak, the highly radioactive solution is retained in the pit until it can be jetted to a permanent storage tank. The pit is covered with 6 in. of lead, 3 in. steel armorplate, and finally a 1/4-in. steel cover plate gasketed and bolted in place. The storage tank is vented to the Building 4507 VOG system, and the pit is vented to the building cell exhaust header.

ORNL Drawings D-45657, E-45659, D-45660, C-45661, and C-SK-55 show the detailed piping connections and valving arrangements associated with the operation of the radioactive waste storage pit vessels T-25 and T-30. Drawing D-45696 shows details of the dry well and sump pump installed adjacent to the pit to prevent leakage of ground water into the pit.

4.0 RADIATION CONTROL

4.1 Health Physics Zoning Practices

Personnel radiation exposures and radioactive contamination are kept under control by zoning practices as carried out by Health Physics. A "radiation zone" is an area where control measures involve external radiation exposure to personnel. A "contamination zone" is an area where control measures involve contamination of employees, environs, and/or equipment and where there is a possibility that radioactive material may be deposited inside the body leading to internal radiation exposure. A "regulated zone" is an area where operations are restricted for the purpose of radioactive contamination control. This zone may contain radiation zones, contamination zones, or both, ranging in size from a small spot to a large area.

The entire building is a "regulated zone." The insides of cells 1, 2, 3, and 4 and the penthouse are designated "contamination zones" all the time and the charging area is designated a "contamination zone" when conditions warrant. Cells 1, 2, 3, and 4 area are also "radiation zones."

Zones are posted with relevant instructions regarding entry, occupancy, and departure. Necessary coveralls, laboratory coats, caps, gloves, shoe covers, masks, etc. are provided for contamination zone operations. Personnel from the Health Physics Division provide necessary radiation monitoring, surface contamination surveys, personnel checks, consultation, etc. required during "hot" operations.

4.2 General

All radioactive processing is carried on in vessels inside the shielded cell, which is the primary containment enclosure. The surrounding building is the second line of defense, which insures that any airborne radioactive that may escape the primary containment will not be scattered to the environment.

All openings into the cell block are gasketed and sealed to withstand 10 in. H_2O pressure. The one exception to this condition is

cell 4, which is presently being operated on a "limited activity" basis (max 100 curies), without complete sealing. About January, 1962 this cell will be shut down, decontaminated, and emptied of equipment; at this time the cell will be modified to provide total sealing. Procedures for sealing cells to meet containment criteria are described in Sect. 4.5.

Differential air pressures from cell to building to atmosphere are arranged so that air flow will always be from the clean region to one of potentially greater contamination. With the building air flow system in balance, differential pressure in the operating area and the charging area will be -0.30 in. water gauge relative to outside. The ΔP from the operating area to the cell interior will be rather large: nominally -1.0 in. WG with a minimum tolerance of -0.70 in. Thus, air flows continuously from the operating area through the change room into the charging area, then into the cell via the filtered inlet air ducts, and finally exhausts from the cell to the 3039 stack. Similarly, air flows from the makeup area, ΔP -0.30 in. relative to outside, down to the charging area and into the cells. The penthouse, completely isolated from other areas, is maintained at -0.30 in. relative to outside. When a cell access hole is opened in the penthouse, air flow is always downward into the cell since the cell has a much higher differential pressure than the penthouse. The differential pressure monitoring system is described in Sect. 7.0.

Personnel doors in the secondary containment shell are vestibuled, i.e., double doors forming an air lock. These doors are to be opened one at a time such that the secondary containment is not broken. One exception to this rule is the vestibuled entrance at the west end of the operating area: occasionally, these doors must be opened simultaneously for short periods when manipulators are moved in or out of the operating area. Permission of building supervision must be obtained before opening both doors.

The monorail door in the charging area and the gantry crane door in the penthouse are not vestibuled, and normally remain closed. Use of these doors is controlled by the building supervision, see Sect. 6.0.

If a release of activity from the primary containment zone, i.e.

the "hot" cells, occurs, containment of the building must be actuated manually by personnel evacuating the building. Three inside and one outside containment switches are provided. When one or more of the red "contain" buttons are punched, containment devices are actuated and the evacuation horn is heard throughout the building. Later, containment will be actuated automatically when any two radiation monitoring instruments "see" a release of activity. Again, the evacuation horn will be heard in all areas. Specific containment features are discussed in Sect. 7.0.

4.3 Radiation Monitoring Provided

Radiation monitoring in 4507 at the completion of the containment is as follows:

Penthouse Area. Two each Q-2240 Constant Air Monitor (CAM). A signal from both these instruments is required to change the building ventilation system from the "normal" state to a "containment" state. Should one of these instruments fail or otherwise be taken out of service - the remaining good instrument will switch the ventilation system into "containment" upon signal. If both instruments fail, the ventilation system will then go into "containment" also. The instruments are set by HP to alarm with flashing white light and intermittent bell ringing at MPC point. A red light burns and the bell rings continuously at full scale (10^5 c/m), indicating evacuation is required.

One each Q-2091 β-γ count rate meter for personnel monitoring at the personnel exit from penthouse. Its purpose is to detect the presence of unsuspected sources of contamination on personnel which may arise in hot operations. The instruments may be set to alarm with a ringing bell at any point on 5 scales and also indicate radioactivity with an audible count rate "pop."

One each Q-2091 α count rate meter at the personnel exit from penthouse. This is also a personnel monitoring instrument with a probe head for the measurement of α contamination.

Makeup Area. One Q-2508 count rate meter with two γ probes for continuous monitoring of wall sleeves in this area.

Charging Area. Two each Q-2240 CAM's. Same setting, alarms, and function as penthouse CAM's.

Four each Q-1154 β-γ count rate meters (monitrons). These instruments are set to alarm with a continuously ringing bell at 7.5 mr/hr on the low scale and at about 30 mr/hr on the high scale. The instruments are normally operated on the low scale.

Change Room. One each Q-2091 β-γ count rate meter for personnel monitoring.

One each Q-2091 α count rate meter for personnel monitoring.

One each Q-1257 quintector for β-γ personnel monitoring; bell rings at variable set points.

Operating Area. One each CAM.

One each Q-1154 monitrons.

One Q-1939 hand and foot counter for personnel monitoring.

Cold Tunnel. One each Q-2091 β-γ count rate meter. This instrument is part of a system which samples and analyzes the process cooling water waste stream for radioactivity.

Criticality. Criticality in Building 4507 is controlled by mass limitation. With the exception of the Cell 1 Immi Facility, most experiments are of such a small scale that criticality is not a problem. Review and approval by the Criticality Committee is mandatory in the event that amounts in excess of 500 g U^{235} or 350 g U^{233} or Pu^{239} are handled in any experiment.

5.0 GENERAL DESCRIPTION OF OPERATING PROCEDURES

5.1 Process Operations

Although the "hot" cell operations conducted at Building 4507 are basically experimental in nature, certain routine procedures are followed to ensure safe, efficient operations and reliable experimental results. Normally, a limited number of runs are planned, which will consume a small quantity of fuel specimens of a specific type and known irradiation history. Operating instructions are written by the scientist supervising the operation to enable the operator (technician) to perform the work in a safe, competent manner. These instructions also provide a detailed record of the experimental procedure as originally conceived. As the work progresses, all the experimental manipulations, observations, and unusual happenings are logged in a bound notebook. Usually, unforeseen incidents or deviations from the planned procedures are dealt with by the scientist-technician team. Under normal circumstances, the group leader, building supervisor, and other responsible persons are consulted before the planned procedure is altered.

All operational planning and equipment design for installation in a hot cell must have the approval of building supervision, and if over 250 curies of fission products or 1 g Pu equivalent, the approval of the Division Radiation Control Officer. Before experiments are designed for installation in one of the "hot" cells it is therefore the responsibility of the operating and design groups to meet with building supervision and RCO in order to schedule the proposed cell installation, operation, and removal in coordination with operations in the other cells. It is also possible that building supervision may assist in the design of the equipment and operations with suggestions on remote operation with manipulators and in methods of operation that will not interfere with the experiments going on in the other cells.

5.2 Methods of Handling Fuel Specimens and Process Samples

Irradiated fuel specimens from various power and test reactors at ORNL and other sites are procured for use in the experimental programs.

In addition, special prototype fuels are fabricated, tested for structural stability, and irradiated under closely controlled conditions in various high-flux test reactors such as the ORR, MTR, and NRX. After discharge from the reactor and sufficient aging to permit decay of short-lived radioelements, the fuel specimens are transferred to the Chemical Development canal and storage garden, Building 3597, in sealed watertight metal containers inside lead-shielded carriers. The containers may be stored for indefinite periods in the canal with 11 ft of water shielding or in dry capped wells 12 ft deep. Fuel specimens that have been sectioned, resulting in exposed core material, are placed in bottles, which are stored in the watertight containers to provide double containment. The precaution is not necessary with specimens whose cladding is known to be intact. Details of operation of the Hot Garden and Storage Canal may be found in ORNL-CF-60-8-88.

As the need arises, fuel containers are transported individually from the storage area in a lead-shielded carrier specially designed for either top or bottom loading and unloading of the container. At Building 4507 the carrier is moved to the top of the cell block and positioned over an access hole leading vertically through the roof plug into the cell. (All access holes into the cells are sealed except during loading and unloading of radioactive materials.) The bottom plug is removed from the carrier and the fuel container is lowered into the cell by a stainless steel cable and reel. The container is detached from the cable which is then withdrawn from the cell. Manipulators are used to open the container with a special wrench, and the contents are removed.

Generally, the same equipment and procedure are used to remove and transport highly radioactive liquid samples from the "hot" cell to the High Level Analytical Facility in Building 3019. Nominal 5- to 10-ml samples from the process are sealed in glass or polyethylene bottles, placed in an enclosed container having racks to accommodate 12 bottles, and withdrawn from the cell into the shielded carrier. This same procedure is used for transfer of radioactive material from one cell to another. Detailed procedures for movement of specimens and samples are described in ORNL-CF-61-8-36.

"Hot" samples must not be removed from the cells via the transfer drawers.

5.3 Housekeeping

Good housekeeping is a first line of defense against the hazards of contamination and radiation. During day-to-day operations, good housekeeping affords protection to operating and maintenance personnel against accidental exposure. If an incident does occur that releases large amounts of radioactive material to the nonradioactive operating areas, the task of confinement and decontamination is substantially reduced if the building and environs have been maintained in a clean, orderly state.

Listed below are good housekeeping practices observed in Building 4507 during normal operation. During periods of extensive construction or accidental contamination, these procedures cannot, of necessity, be rigidly followed.

Nonradioactive Operating Areas and Change Area. At three-month intervals, walls, beams, cabinets, lighting fixtures, piping, etc., are vacuumed and washed to remove accumulated dust and stains. Floors are swept daily and washed and waxed weekly. On special occasions extra manpower is obtained to clean large areas when these areas become more than ordinarily soiled.

Front Operating Area. The operating groups keep all equipment associated with their individual cell in a clean and orderly fashion. They are also responsible for the auxiliary area occupied by their operation, including hoods and sink and bench space. Specifically, the floor is kept uncluttered from electrical wiring, piping, glassware, sample carriers, etc., to facilitate cleaning. Bench tops and hood floors are covered with blotting paper, which is changed weekly. Extra gas cylinders are stored in racks provided outside the building. Only a minimum, necessary supply is carried, and empties are returned promptly. No contaminated equipment or material of any kind is stored in the front operating area. Any contamination which occurs in this area is removed as soon as possible; contaminated equipment that cannot be moved is

immediately masked with polyethylene film. Transfer drawers are to be used only for moving materials into the cell.

By restricting the inventory of reagents in the building, a degree of control is exercised over the common hazards associated with the storage and handling of these materials. Laboratory quantities of miscellaneous chemical reagents may be stored in approved containers in metal cabinets in the front operating area. Solvents should be stored in special solvent storage cabinets provided. Bulk chemicals such as acids and caustic may be stored in metal cabinets in the makeup area. Gas cylinders are restricted to those actually in use in the operating areas; extra cylinders and empties are stored in racks outside the building. Fluorine and anhydrous HF are piped to cell 4 from storage tanks outside Building 4507, as is bulk nitric acid for cell 1.

Rear Operating Areas. The same practices recommended for the front operating area also apply to the charging and makeup areas with some modifications. Small items of lightly contaminated equipment, properly bagged in polyethylene, may be stored in the makeup area until they can be decontaminated. After gas masks are used in a contaminated area, they are washed with soap, water, and brush, checked by Health Physics, and returned to storage. Several GI yellow cans with lids are provided in the rear operating area. These are intended as receptacles for dry contaminated material which accumulated during entry of a "hot" cell. These cans must be fitted with polyethylene bag liners. When cell entry is completed, the bag liners are sealed before the cans are carried to the dumpster. After disposal of the bagged contents in the dumpster, the cans are returned to the building and fitted with clean liners. In the makeup area, metal cabinets are provided for storage of miscellaneous supplies.

Penthouse. Plugs that seal the access holes into the cells are assumed to be contaminated. When these plugs must be removed, they are bagged and sealed in polyethylene film before storage. The same procedure is followed when any structural members, tools, materials, etc., are withdrawn from the cells. All carriers that arrive at Building 4507 have previously been checked for surface contamination at the pickup point by

Health Physics. Nevertheless, the carrier or any part thereof is placed on disposable blotting paper wherever it is set down at Building 4507. After being emptied, carriers are monitored for beta and gamma radiation and tagged before they are removed from the building. All tools, equipment, materials, and protective clothing used in operations are removed from this area after completion of the operation. Surfaces that become accidentally contaminated are washed and surveyed by Health Physics. Particular care is exercised during transfer of radioactive liquids via this area. Batch transfers and analytical samples are handled only in approved containers. Special transfers of radioactive material are sometimes accomplished by vacuum, steam jetting, or gravity after careful review and approval by supervision of the proposed transfer.

5.4 New Chemical Flowsheets

During tests with new chemical flowsheets, the procedures outlined in Sect. 5.1 are followed; however, certain extra precautions are taken since operating personnel are usually unfamiliar with the new system. Operators first become acquainted with the mechanical features of the system when they assemble the various components in a nonradioactive area. After assembly, the equipment is checked for mechanical operability with manipulators in a special "hot" cell mockup. Next, the system is transported and installed in a "hot" cell, previously decontaminated to allow direct maintenance. This installation is directly supervised by the operating personnel.

When the installation is completed, a series of shakedown runs with unirradiated, prototype fuel are performed which serve to: (1) establish the mechanical operability of the remotely manipulated equipment in the hot cell, (2) determine the chemical operability of the new flowsheet under "hot" cell conditions, (3) provide further opportunity to detect unforeseen hazards in time to eliminate them, and (4) further familiarize the operators with all aspects of the system. When the series of test runs is completed with satisfactory results, the "hot" cell is sealed and charged with a batch of radioactive fuel specimens.

5.5 Procedure for Sealing and Checkout of "Hot" Cells

Although the experimental equipment is designed, fabricated, and extensively tested before installation in a clean, renovated cell, the task of installation of this equipment with attendant service connections, sealing of all cell penetrations, and tests of the adequacy of air tightness, is tedious and time-consuming. The following information is presented to aid the operators and crafts people with this task.

Installation of Experimental Equipment. The installation of heavy, bulky equipment in a renovated cell is generally performed by riggers, supervised by the operating group. Building supervision should be consulted on special problems associated with this task. Intelligent design and planning are needed to avoid accidents and waste of time and manpower.

The connection of service lines from outside to the equipment in the cell are made with plastic tubing, stainless steel tubing and pipe, heavy-duty electrical cable, using specially design 2 1/2 in. dia steel-encased lead plugs with stainless steel sleeves. A limited number of these plugs are supplied by the facility. Additional or special plugs may be fabricated on order from the operating group and charged to the program operating account.

Special care should be exercised in installation of these plugs:

(1) When a plug is removed from a cell access hole, it is assumed to be contaminated. Therefore, it must be bagged in polyethylene film, surveyed by Health Physics, and if contaminated sent to Decontamination. After return from Decontamination it is stored in the racks in the Makeup area.

(2) The sleeved plugs are sealed in place using a neoprene rubber gasket between the inside shoulder of the plug and the face of the access hole sleeve. A threaded aluminum cap holds the plug and gasket in place.

(3) Where possible, tubing and pipe are run through the sleeves and sealed with Swagelok fittings or epoxy resin cement. If necessary, tubing and pipe may be swageloked or welded directly to the sleeves.

Repair and installation of manipulators and their sealed boots should be arranged through building supervision. Building supervision should be consulted regarding the proposed installation of any special sleeves, penetrations, closures, and seals for any cell being readied for "hot" operation.

Final Sealing and Checkout of Cell. Containment criteria specifies that before "hot" operation is attempted the cell must be sealed such that the air inleakage rate is not greater than 1% of the cell volume when the cell is evacuated to -2.0 in. WG. Cell volume for cells 2, 3, and 4 is 660 cubic feet; cell 1 has a volume of 876 CF including the pit. Thus, the allowable inleakage rate for cell 1 is 8.8 CFM, and 6.6 CFM for cells 2, 3, and 4. The following procedure is used by the operating group, aided by building supervision:

(1) All gasketed closures are inspected and tightened by the operating group. All special penetrations into the cell should be sealed with epoxy resin cement. The filtered air inlet is temporarily sealed off at the inside face of the plug door with masking tape.

(2) A man is stationed inside the cell and the plug door is closed and tightened in place with jackscrews. Inspection of the plug door gasket seal will determine if the door is adequately sealed.

(3) A pasteboard box with an opening of known area is taped over the cell exhaust vent. A man with an airflow meter is stationed inside the cell, and the cell door is closed and tightened.

(4) The differential pressure on the cell is adjusted to -2.0 in. WG by appropriate airflow adjustments (consult building supervisor). The exhaust opening is scanned traversely with the airflow instrument to obtain data.

(5) If airflow through the exhaust opening exceeds specifications, suspected inleakage points must be detected and sealed, after which the test is repeated until the inleakage criteria are met.

5.6 Procedure for Entry to "Hot" Cells

The interiors of "hot" cells 1, 2, 3, and 4 have been designated "contamination and radiation zones" according to the rules and regulations contained in Sect. 4.0 of the ORNL Health Physics Manual, ORNL-CF-59-4-46, and Sect. 9 of the RS and C Manual.

Prior to entry into the cells all sources of radiation must be decreased to the lowest practical limit. The cell interior must be surveyed by Health Physics and exposure time limits established prior to entry. Radiation exposure of personnel entering the cells is controlled by the Health Physics surveyor in attendance during the operation. A Radiation Work Permit (UCN-2779) or an Extended Radiation Work Permit (UCN-2781) shall be issued and approved prior to any cell entry.

Personnel entering the cells wear direct-reading radiation monitoring instruments and protective clothing, including "C" zone coveralls, plastic booties, gloves, hats, and gas masks or respirators. Suitable aids, such as blotting paper, plastic film and bags, "hot" cans, etc., are provided to prevent the spread of contamination outside the cell. All tools, apparatus, and other material removed from the cell are checked for radiation and surface contamination before reuse or disposal.

Individuals leaving the cell are monitored by Health Physics in the controlled area behind the cell. Here, contaminated clothing is removed and deposited in "hot" cans. Upon completion of the operation, the area is surveyed by Health Physics for contamination and radiation. A file of Radiation Work Permits and Extended Radiation Work Permits is maintained by building supervision.

5.7 Decontamination of Equipment

Occasions arise when a "hot" cell must be entered for a brief period to perform minor maintenance on the equipment. Before attempting this, the radiation and contamination levels inside the cell should be reduced as far as possible by standard decontamination techniques. Waste solutions are discarded via the hot drains, and certain solutions are salvaged for future use by withdrawal into shielded containers. Unused fuel specimens

may be stored temporarily in a shielded carrier atop the cell block. Using a manipulator-operated radiation monitor, the equipment components and cell interior are checked for isolated spots of high activity. Where possible, highly radioactive pieces of equipment are detached and removed from the cell. Hot spots are frequently found in the stainless steel tray underneath the equipment. This contamination is eliminated by scrubbing the tray with dilute nitric acid and water, the wash solutions being discharged to the "hot" drain. Glass or stainless steel equipment that cannot be readily detached and removed from the cell is treated with a series of decontaminating reagents to remove residual activity.

5.8 Equipment Removal and Cell Decontamination

At the end of an experimental program it is the responsibility of the operating group to dismantle and remove all equipment to provide space for new experiments. The procedure outlined in Sect. 5.6 and 5.7 is used. Cell entry is made and the system is rapidly disconnected from all services and outside lines. The system may then be removed from the cell via the rear plug door or through the roof. Before removal, it is sheathed in polyethylene film to contain any particulate contamination which might be lost during transport. After removal, it may be partially salvaged to recover special equipment, the rest being sent to the burial ground.

With all equipment removed, the cell interior must be completely decontaminated. The walls and floor are scrubbed with detergent solution, which is carefully flushed into the "hot" floor drain with water. Three or more such treatments are sometimes needed to reduce residual activity to 30 d/min α and/or 1000 d/min β,γ over a 100-cm^2 area as determined by Health Physics smear counting. When this specification is met, the cell is ready for maintenance operations.

The operating group will submit to the building supervisor a written report of the condition of the cell and service equipment, certifying that the cell is clean and meets all Health Physics tolerances before they are released from responsibility for the cell.

5.9 Disposal of Radioactive Materials to Burial Ground

Operators of the Burial Ground have requested that the following recommendations be observed:

(1) Give sufficient prior notice to the Burial Ground foreman so that he may arrange for necessary crafts help and advice from HP and Fire and Safety Departments on nonroutine burials.

(2) Adequately describe what is to be buried.

(3) Fill out Burial Ground From UCN-2822 or a Radioactive Materials Transfer Tag for each item, and give to pickup personnel.

(4) Hot cans should be lined with plastic, surveyed, tagged, and the lids taped to the cans.

(5) Yellow Dumpsters are picked up on schedule, and should be surveyed, tagged, and closed before pickup.

5.10 Operations Involving Potential Release of Contamination from "Hot" Cells

Periodically it is necessary that certain operations be conducted which involve incident contamination of the ordinarily clean operating areas and penthouse. Such operations include: removal of analytical samples from the "Hot" cells, removal of contaminated solid waste, cell penetration for service or equipment alterations, and other special cases which may arise from time to time. Procedures should be used which are designed to contain and rapidly dispose of all radiation sources and incident contamination resulting from such operations. The following rules apply to those procedures:

(1) Any operation or procedure expected to release incident contamination or radiation outside the cells must be approved by the building supervisor, or his alternate.

(2) Such operation or procedure must be conducted under HP supervision.

(3) All reasonable means must be employed to prevent the spread of incident contamination within the operating areas and penthouse, and especially outside the building.

(4) Upon completion of the operation or procedure, all expendable contaminated items must be bagged and sealed in plastic and immediately removed to the dumpster.

(5) Contaminated tools or equipment retained for reuse must be sealed in plastic and stored in cabinets provided.

(6) Contaminated bulky equipment such as carriers must be sealed in plastic until time is found for decontamination.

6.0 ADMINISTRATIVE CONTROL

Certain of the containment features must be regulated administratively if effective containment is to be achieved during an emergency. Since a release of activity may occur at any time within the building, there must be at least one line of containment present to prevent the escape of this activity from the building. The following procedures described are based on this principle.

All actions involving administrative control should be referred to the Building Supervisor, J. R. Flanary, for decision. In his absence, J. H. Goode is designated as Alternate Building Supervisor. If both of these individuals must be absent, one of the supervisors in charge of individual "hot" cell operation will be appointed Alternate Building Supervisor.

It is the direct responsibility of the supervisor of individual cell operation to assure that these procedures involving administrative control are followed. It is recommended that these special procedures be written into the individual cell operations procedures, preferably as a checklist in the log of cell operation. These records should be available in the operating area so that cell operators and building supervision can determine the current condition of any "hot" cell.

6.1 Loading or Removal of Radioactive Materials from Cells Via the Penthouse

Routine procedures for transfer of radioactive materials to and from the "hot" cells via the penthouse are detailed in ORNL-CF-61-8-36, entitled "Routine Transfer of Radioactive Materials between Buildings 3019, 3597, and 4507." However, additional administrative control must be exercised, according to the following checklist:

(1) The gantry crane door on the west end of the penthouse must be kept closed at all times except when materials are moved to and from the penthouse using the crane. Permission to open this door must be obtained from the building supervision. This house rule is emphasized for the benefit of nonoperating personnel by a sign on the door.

(2) During transfer of materials to and from the penthouse when the door is necessarily open, all openings from the penthouse into any "hot" cell must be sealed.

(3) Before any access hole into the "hot" cell is opened, the gantry crane door must be closed and the track seals in place.

(4) Before any access hole into the "hot" cell is opened, it must be established that the differential pressure on the cell is at least -0.50 in. water gauge relative to the penthouse. This is determined by reading three differential pressure gauges on the central panel board, operating area. The DP on each cell is monitored relative to the operating area. This reading is nominally -1.0 in. with a minimum of -0.70 in. The DP of the operating area is monitored relative to outside; this reading is nominally -0.30 in. with a minimum of -0.10 in. The DP of the penthouse is monitored relative to outside; this reading is nominally -0.30 in. The following formula applies:

$$DP(\text{Cell/Penthouse}) = DP(\text{Cell/Operating Area}) + DP(\text{Operating Area/Outside}) - DP(\text{Penthouse/Outside})$$

Failure to observe these precautions could result in a pull of contaminated air into the penthouse when any access hole is opened in this area.

6.2 Loading or Removal of Radioactive Materials from Cells Via Charging Area

Administrative control must also be applied to the movement of materials to and from the cells via the charging area. This area is provided with a monorail and two-ton hoist which may be used, for example, to transfer equipment into a cell being readied for "hot" operation or remove contaminated equipment from a cell which is being decontaminated. The monorail extends through a double door on the west end of the building. This door has no vestibule; therefore, it is regulated much like the gantry crane door.

(1) The monorail door must be sealed and locked at all times when the building is in "hot" operation. Permission to open this door must be obtained from the building supervisor, or his alternates. One set of keys will be kept in the building supervisor's office, A-30, 4500; the other emergency set will remain in a locked cabinet located in the east vestibule, operating area.

(2) Before this door is opened, all normally sealed openings to all "hot" cells must be closed.

(3) Before any "hot" cell is opened, the monorail door must be closed and locked.

(4) Before any "hot" cell is opened, it must be established that the differential pressure on the cell is at least -0.50 in. WG relative to the charging area. This is determined by gauge readings on the central panel board, operating area, and the following formula:

$$DP(\text{Cell/Charging Area}) = DP(\text{Cell/Operating Area}) + DP(\text{Operating Area/Outside}) - DP(\text{Charging Area/Outside})$$

(5) Since the system of airflow and balance is quite sensitive to upsets, it is necessary to adjust the exhaust damper on the cell being opened to reduce the excessive flow of air occurring when the large plug door is opened. These dampers are locked in position; one set of keys are retained by the building supervisor; an additional set remain locked in the emergency key cabinet in the east vestibule. Before opening the plug door, the damper should be adjusted to the "closed" position. (Dampers are arranged so there is always some exhaust on the cell; normally 240 CFM at the "closed" position.) Permission to change damper setting must be obtained from the building supervisor.

6.3 Vestibule Doors

There are six vestibule doors provided for personnel access to Building 4507. These entries are provided with double sets of doors individually sealed for airtightness to form air locks. Permission to open both doors of any vestibuled entry at the same time must be obtained from the building supervision. This regulation appears on each vestibule door for the benefit of nonoperating personnel.

6.4 Valve Pit Serving the Building 4507 High-Level Radioactive Waste System

As outlined in Sect. 3.3, liquid radioactive wastes are collected by two 2-in. headers emerging from the east side of Building 4507 and turning south to connect with a 4-in. header, the so-called Chemical Waste Line, tying Building 4500 to the Liquid Radioactive Waste Tank Farm. The two 2-in. headers are intercepted by a valve pit located outside and adjacent to the southeast corner of Building 4507. One of the headers serves the entire bank of four cells; the other serves Cell 1 only. Both lines are valved such that liquid waste can be routed directly south to the 4-in. header leading to the Tank Farm; or the liquid waste, if especially "hot," can be routed to a new 2-in. header, the so-called Metal Waste Line, leading west to WC-14, an underground tank for segregation and retention of such waste.

Cell 1, while operating the Pu-Al Alloy process, will normally discharge any high-level radioactive waste via its exclusive 2-in. header to WC-14. The remaining three cells will normally discharge their liquid waste directly south to the 4-in. Chemical Waste Line. The valving arrangement and routing of these waste lines is diagrammed on the valve pit cover. The valves are fitted with extension handles through the cover, and capped to discourage anyone from tampering with the valve positions. Permission to change the valving arrangement must be obtained from building supervision and E. Witkowski.

6.5 Cell Hot Drain System

Cells 2, 3, and 4 are each equipped with a "hot" floor drain and two elevated "hot" drains. Cell 1 is similarly equipped except it has a sump with steam jet connection to a process vessel instead of the standard floor drain. The floor drains are not trapped; however, they are fitted with gasketted stainless steel plugs which may be operated remotely. Since the "hot" drain system is interconnected, it is necessary that the floor drain plugs be in place at all times when not in actual use; failure to observe this precaution can result in activity being pulled from the open floor drain into any adjacent cells operating at a lower pressure.

6.6 Maintenance of Radiation Monitoring Instruments

All of the radiation monitoring instruments are the responsibility of Health Physics. Health Physics personnel make periodic inspections of these instruments and arrange for maintenance as required. If an instrument is observed to be erratic or out of service, immediately refer the matter to the HP office in 4500 Building, Room A-32, phone 6997.

7.0 EMERGENCY PROCEDURES

At present the building is equipped with four manual switches, any of which can be used to actuate emergency containment of the building. Later, emergency containment will be actuated automatically by a system of activity monitors. Figure 1 shows the location of the manually-actuated containment switches.

If an incident occurs within the cells, i.e., a pressurization, explosion, fire, or failure of the cell off-gas system, resulting in a release of activity from the cells into the secondary containment areas, such activity will be "seen" by monitrons or by constant air monitors. When the tolerances of these instruments are exceeded, audible alarms are actuated. When the alarms sound, the building must be evacuated immediately by all personnel.

With the manually-actuated system of emergency containment, one or more of the evacuating personnel must punch one of the containment switches as he leaves the building. When the red "Contain" button is punched, the following events occur:

(1) All of the louvered air inlets into the secondary containment areas are closed automatically.

(2) The two air conditioning units serving the building are stopped.

(3) The exhaust fan supplying normal ventilation to the penthouse is stopped.

(4) The damper on the hood exhaust from the front operating area is closed.

(5) The damper on the 12-in.-dia duct connecting the penthouse to the cell off-gas header is opened.

(6) The building evacuation horns sound.

At the time these events occur, it is expected that all entries to the building are closed. However, should one or more doors be open at the time of a release of activity, there is a fair probability that the inward air flow system might block its escape from the building. Any

open doors should be closed as soon as possible after an incident occurs. These include six vestibules for personnel, i.e., double doors forming an air lock, one monorail door on the west end of the charging area, and the gantry crane door on the west end of the penthouse. Use of the monorail and gantry crane doors is controlled administratively (Sect. 6.0). With all air inlets to the building closed, contaminated air will be exhausted from the front operating area, the change room, and the makeup area into the charging area, then into the cells, and finally from the cells via the cell off-gas header to the 4500 area filter house and the Building 3039 stack. Contaminated air will be exhausted from the penthouse, an area completely sealed off from the rest of the building, via the 12-in.-dia duct tying into the cell off-gas header. Shutdown of the air conditioners is necessary to reduce the spread of contamination by air circulation.

It should be recognized that there will be occasions of spurious containment. When these occur, the building can be taken out of emergency containment by (1) punching the green "Reset" button on the containment switch which resets the relays, and (2) punching the "Start" button on the switch which controls the penthouse exhaust fan. With these actions, the louvers on the various air inlets will open.

A containment panel board is located on the south wall of the operating area which gives a visual and audible indication, i.e., a red light and stroking bell, when each feature of emergency containment is activated. Failure of any or all of the containment features is evident by absence of a red light. Under normal building operation, no lights show on the panel.

A second panel nearby carries the differential pressure gauges which continuously monitor the four cells, the operating area, the charging area, the makeup area, the penthouse, and the cell off-gas header. It is desired to operate the operating, charging, makeup areas and penthouse at -0.3 in. water gauge relative to these areas. The pressure differential gauges are instrumented to give an audible alarm (buzzer) and red annunciator light at the panel when the differential is reduced to -0.1 in. or

less. The gauges monitoring differential pressure in the four cells are arranged similarly with a minimum tolerance of -0.70 in.

Table 1 lists all alarms in Building 4507 and appropriate action to be taken.

Each cell has its own filtered air inlet protected by a backflow preventer, an absolute filter, and a duststop filter. The pressure drop across these air inlets is continuously monitored by gauges located on the back of each of the cell plug doors. When the pressure drop across these filtered openings becomes excessive, filter change is necessary.

Daily inspection of these filters and pressure drop readings will be included in the building containment checklist prepared by R. E. Brooksbank. Brooksbank, in charge of Cell 1 operations, will assume responsibility for the daily inspection and tests of all containment features.

7.1 Emergency Evacuation Procedure in the Event of Fire, Explosion, or Activity Release

When an alarm sounds indicating that one of the activity monitoring instruments has "seen" a release of activity:

(1) Personnel working in the area where the release is "seen" by the radiation monitoring instruments will hear the bell alarm. They should evacuate the building by the nearest exit.

(2) As they exit, all personnel should punch the red "Contain" button on the containment switch nearest their path of exit. This action, in addition to actuating containment, will sound the evacuation horn which is audible to personnel in every area of the building.

(3) As they exit, personnel should actuate the fire alarm boxes located on the east wall of the charging area and on the west wall (outside) the operating area. This action will bring the laboratory shift supervisor, guards, Health Physics, and the Fire Department to the scene.

(4) Once outside, all personnel must proceed to the covered passageway connecting Buildings 4507 and 4500, Wing 1. This area is a designated assembly point and emergency Health Physics check station.

(5) Upon assembly, a head count of personnel should be made to determine whether everyone working in the building is safely out and assembled.

(6) No person should leave the assembly point until he has been surveyed for contamination by Health Physics and released.

(7) If it is uncertain that anyone actually punched one of the containment switches during exit, a man should be sent to the west end of Building 4507 where a containment switch is mounted outside.

(8) No re-entry of the building should be attempted unless authorized by the building supervisor, laboratory shift supervisor, or other responsible individual. Re-entry must be conducted under the supervision of Health Physics.

(9) The building supervisor or his alternate will appoint persons to perform the following duties:

West Sentry: Keep unauthorized persons away from building.

East Sentry: Keep unauthorized persons away from building.

Searcher: Don protective clothing, and with HP assistance, enter building and determine that all persons have been evacuated.

(10) Emergency equipment and a supply of protective clothing is stored in cabinets in the passageway between Buildings 4507 and 4500.

7.2 Other Emergencies

(1) Emergencies requiring medical assistance, guards, etc., should be reported by telephone using the emergency telephone number posted beside each telephone.

(2) Emergency Shutdown of Equipment. Each person responsible for the operation of any cell in the building shall determine the location of all cut-offs for building services supplying his cell with the assistance of the building supervisor, and shall inform his operating personnel of these locations by including them in his written procedures. Briefly, steam, water, air, and gas may be cut off in the Building 4505 cold tunnel;

local electric power at Power Panels X and Y and Lighting Panel "A" in the charging area; Lighting Panels "B" and "C" in operating area; vacuum in the charging area. The main Building 4507 480 V, 3 ϕ electrical power shut-off is a labelled 400 amp circuit breaker located on a "Square D" panel in the SE sector of the basement of Building 4501, 15 ft NW of the double doors leading into the basement of Building 4505; it may be reached by going down the stairway at the east UNOP (4505) entrance, down the NE stairwell of 4501, or through the tunnel connecting 4500 and 4505.

Power failure, shut-off of the main breaker in Building 4501, shut-off of circuit 2 in Power Panel "Y" or circuits 11 and 12 in Lighting Panel "C" will cause the building to enter the "fail safe" containment condition.

(3) Laboratory Wide Evacuation. Shut down equipment and put building on containment. Evacuate as directed by P.A. system.

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