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ISOTOPES DEVELOPMENT CENTER

HAZARDS REPORT FOR BUILDING 3028-E

(Curium Source Fabrication Facility)

R. W. Schaich

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Isotopes Division

MARCH 1964

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
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HAZARDS REPORT FOR BUILDING 3028-E

ABSTRACT

A critical review of the hazards associated with the operation of an alpha-neutron source fabrication facility (Building 3028-E) is presented. The physical facilities, chemical operations, and operating procedures for the plant are described. Analyses are made of the maximum credible accident in curium-americium processing. It is shown that the primary and secondary containment features of the facility are adequate to reduce alpha contamination external to the building to permissible levels in the event of a maximum credible accident.

SUMMARY

The Source Fabrication Facility (SFF) will be used for the fabrication of Am^{241}-Cm^{242} and Cm^{244} power sources for the space program. The feed material to this facility will be purified in the Curium Recovery Facility (Building 4507) and transferred as an aqueous solution for final processing and source fabrication.

In the SFF, 15 g of Cm^{242} or 50 g of Cm^{244} can be fabricated as an encapsulated source form which is free of alpha contamination. The cell arrangement provides for segregation of operations involving different levels of potential alpha contamination so that succeeding operations proceed through decreasing contamination levels between cells until the final cell is smear clean for source handling. The segregation is accomplished by air locks between cells and close control of the circulation of air between cells.

The expected capacity of the SFF and the maximum inventory figures are summarized below.

Material	Maximum Plant Inventory, g	Maximum Vessel Inventory, g
Am^{241}	500	150
Am^{243}	500	150
Cm^{242}	50	15
Cm^{244}	500	150

The equipment is designed to process Cm^{242} or Cm^{244} on a campaign basis.

The SFF equipment for controlling the release of radioactive wastes to the environment is designed for an absolute minimum discharge under normal operating conditions. In the event of an uncontrolled release of either gaseous or liquid activity, the facility is designed to contain the activity within the confines of the building. The maximum credible accident in the SFF would be the explosive release of 15 g of Cm^{242} from a non-vented precipitator (Table 7.1).

1. PHYSICAL PLANT DESCRIPTION

1.1. Building Description

The source fabrication facility (SFF) is located on the northwest corner of Isotope Circle in the Isotope Area (Fig. 1.1.1) and is adjacent to the 3039 stack area. It is located in Building 3028 which also contains the I^{131} production facility on the west side. An air lock separates the SFF from the Radioisotope Development Laboratory (Building 3047) on the east. There are no direct personnel accesses between the SFF and the I^{131} facility or Building 3047. Its relation to near-by facilities in terms of distance and quantities of radioactivity normally handled is listed in Table 1.1.1.

Table 1.1.1. Adjoining Facilities and Activity Inventories

Building No.	Title	Distance Feet	Distance Direction	Maximum Activity Inventory, Curies	Activity Type
3047	Radioisotope Dev. Laboratory	10	East	1×10^6	Fission Products Transuranium Elements
3029	Multikilocurie Cells	30	South	5×10^5	Fission Products Co^{60}

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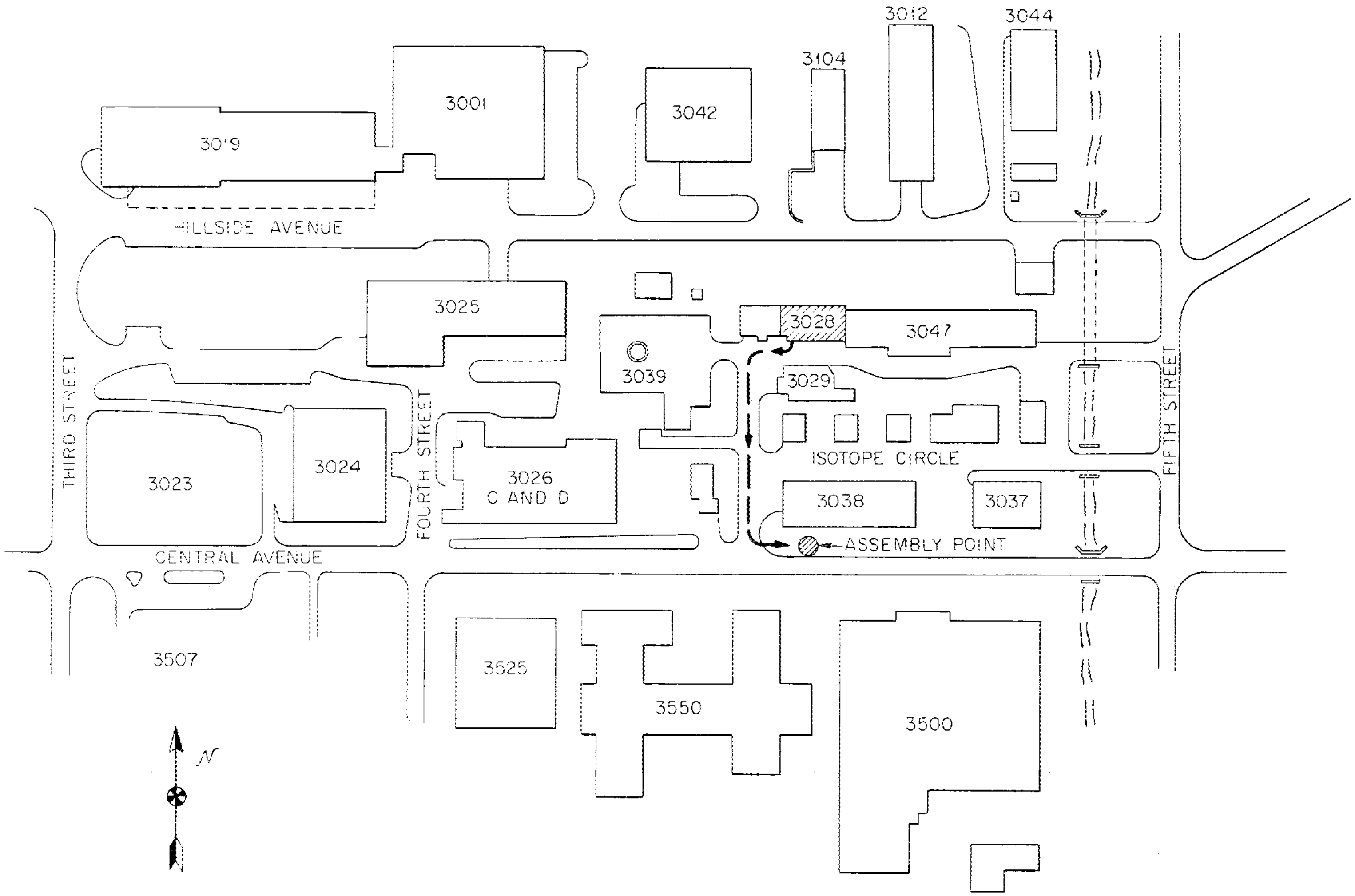

Fig. 1.1.1. Bldg. 3028 Evacuation Route

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Table 1.1.1 (Cont'd)

Building No.	Title	Distance Feet	Distance Direction	Maximum Activity Inventory, Curies	Activity Type
3028-W	I^{131} Facility	0	West	1×10^3	Fission Products
3039 Area	Gaseous Waste Disposal Area	100	West	0	Fission Products
3042	Oak Ridge Research Reactor	150	North	1×10^5	Fission Products
3030,3031, 3032,3033	Radioisotope Laboratories	100	South	1×10^3	Miscellaneous Radioisotopes
3038	Radioisotope Packing and Analytical Lab.	150	South	1×10^3	Miscellaneous Radioisotopes
3037	Isotopes Div. Office	225	South	None	None

The SFF building, a steel-frame structure covered by corrugated aluminum siding, consists of a four-story operating area and a one-story controlled area behind the cells (Figs. 1.1.2 and 1.1.3). The first floor area of the building covers 2000 ft^2 and the total volume is 56,000 ft^3 of free space.

1.2. Cell Descriptions

The SFF cells consist of two existing cells that have been converted to alpha-neutron operations and four new water-shielded cells. An existing 9-in. armor plate cell was converted to neutron operation by the addition of 1 ft of standard concrete shielding, a water-filled door, and an oil-filled window. The door is hinged and gasketed to prevent the escape of alpha activity.

An existing barytes concrete cell with 1.5 ft shielding was converted to a low level alpha-neutron cell and contains the primary off-gas filter system and the process vacuum equipment. This cell has a sealed door for direct maintenance access to the equipment. The four new cells consist of

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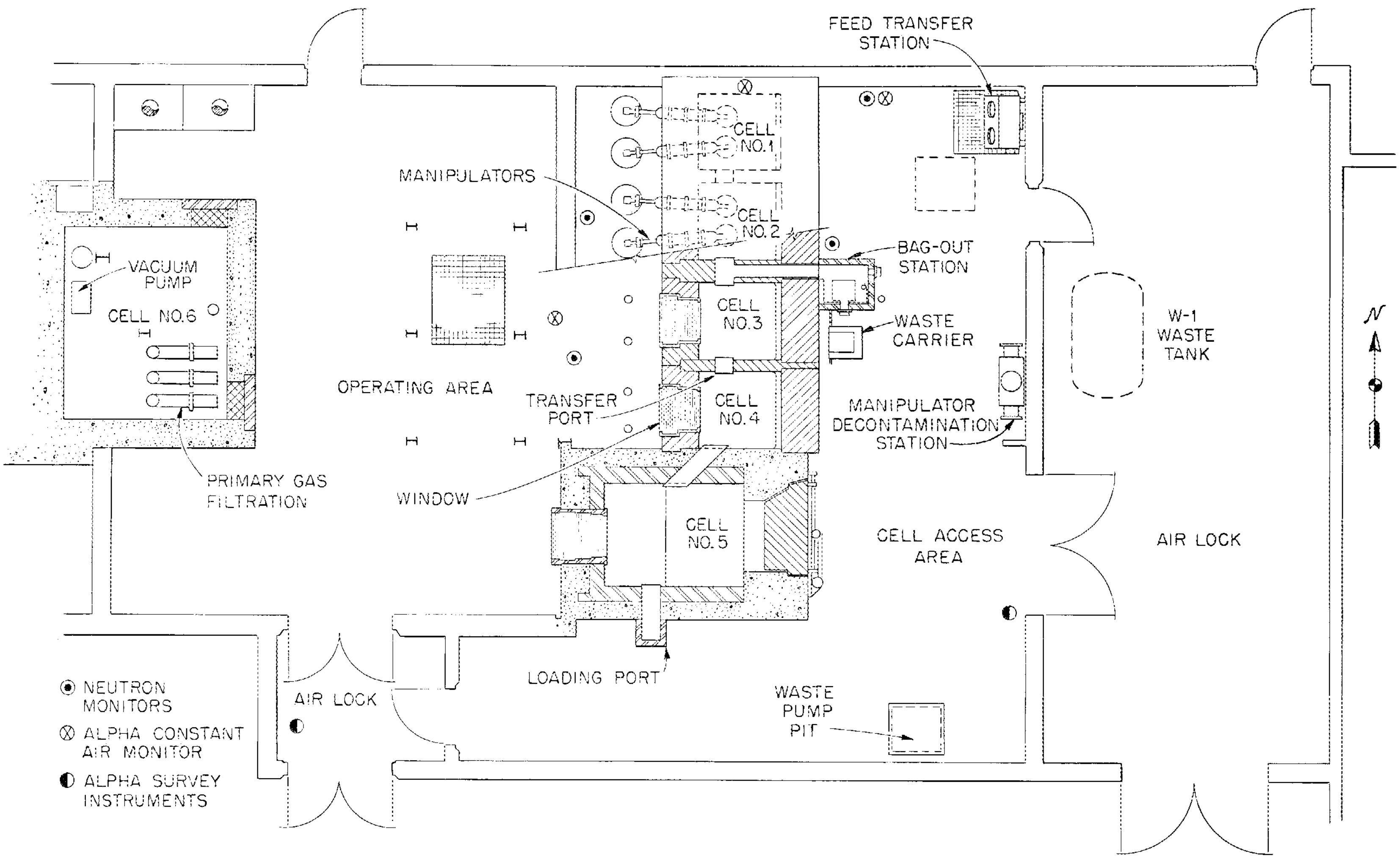

Fig. 1.1.2. Cell Plan, Bldg. 3028

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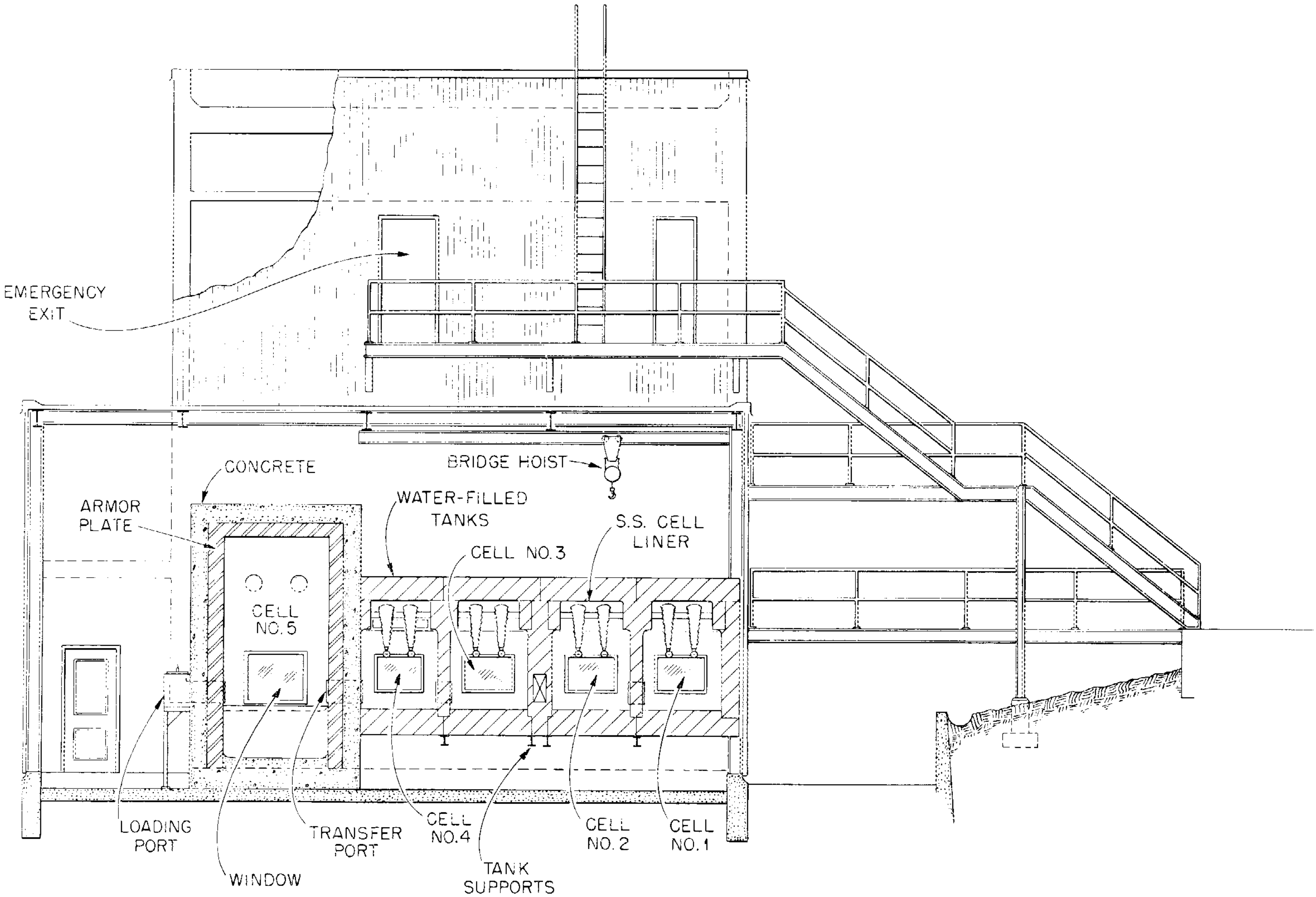

Fig. 1.1.3. Section A-A

steel tanks that contain two ft of water shielding. The tanks are bolted together to form the basic cell arrangement and a stainless steel liner is installed in each cell to seal all accesses to the cells (Fig. 1.2.1). All penetrations to the cell are welded at the liner and the cells are connected in series with an air lock system. Extended-reach Model 8 manipulators are inserted through holes in the top of the cells which are covered by water-filled tanks for neutron shielding. The slave sections of the manipulators are covered with urethane manipulator boots sealed to the inside top surfaces of the cells. An additional plastic boot and wiper seals around the tapes in the manipulator barrels provide a secondary containment for the manipulator penetration. Personnel access to the cells can be made by draining the water from the back shielding block and removing the tank. The opening is also covered by a plexiglas plate with glove ports which is gasketed to the cell liner and which is removed for direct access to a cell.

The SFF cell characteristics are tabulated in Table 1.2.1.

Table 1.2.1. SFF Cell Characteristics

Cell No.	Liner	Shielding	Designed External Radiation, mrem/hr	Process
1	Stainless	2 ft H_2O	<1	Precipitation
2	Stainless	2 ft H_2O	<1	Powder preparation
3	Stainless	2 ft H_2O	<1	Pelletization
4	Stainless	2 ft H_2O	<1	Welding
5	Stainless	9 in. steel + 1 ft concrete	<1	Welding
6	Epoxy Resin	1.5 ft barytes	<1	Off gas cleanup

Personnel access to all SFF cells is controlled by the Procedure for Personnel Entry to SFF Cells.[1] All doors are sealed and locked under normal operations and are not entered until decontamination procedures have lowered radiation and contamination levels to acceptable standards.

1.3. Cell Services

The SFF cells are equipped with standard services to vessels and cell areas. Table 1.3.1 lists the various services available for in-cell operations.

[1]Appendix No. 1.

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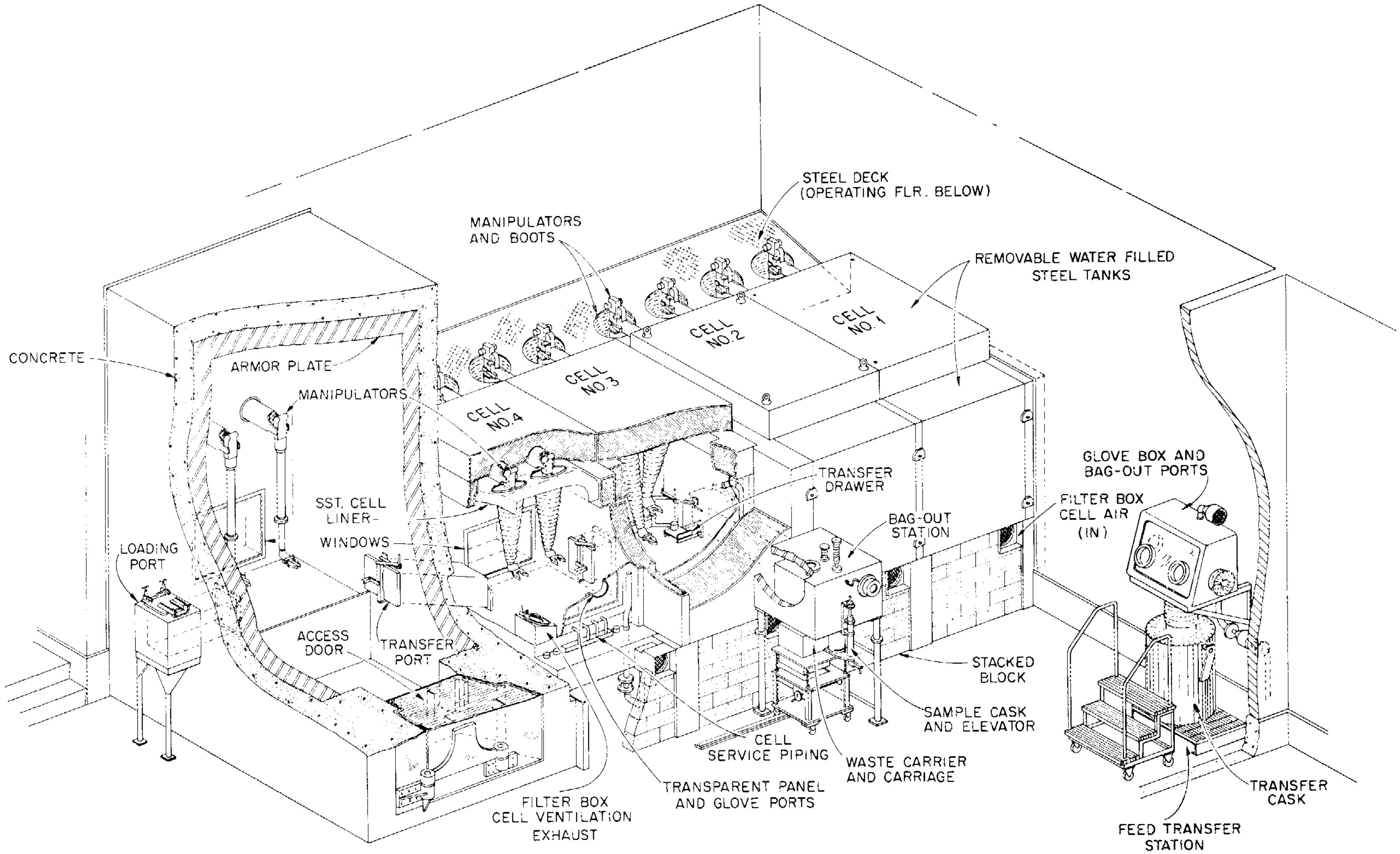

Fig. 1.2.1. SFF Schematic

Table 1.3.1. SFF In-Cell Services

Cell No.	Argon or Helium, 30 psi	Steam, 30 psi	Chilled Water	Distilled Water	Air	Process Water	Process Vacuum	Off-Gas
1		X	X	X		X	X	X
2	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X
5	X	X		X	X	X		X
6						X	X	X

1.4. Process Equipment

The process equipment for the SFF consists of small stainless steel vessels for aqueous solution handling, stainless steel filters, furnaces for calcination of powders and pellet sintering, a hydraulic press for pelletization, and calorimeters for thermal measurements.

The aqueous vessels are operated from a graphic panelboard, and all solution transfers are made by vacuum and gravity flow. After the powder is formed, all handling operations are accomplished with extended reach Model 8 manipulators. Due to the heat output of the Cm^{242} product, powder and pellet transfers are made in containers cooled with air or chilled water. The cell pans are cooled with chilled water to control cell temperatures and to remove heat in case of accidental spillage of radioactive material.

The characteristics of the vessels used in SFF are listed in Table 1.4.1.

Table 1.4.1. SFF Vessels and Characteristics

Tank No.	Material Type	Volume, Liters	Agitation	Process
T-11	304 L	13	None	Feed transfer
P-11	304 L	13	Agitator	Precipitation
R-11	304 L	20	None	Vacuum receiver
S-11	Glass	0.5	None	Sampler
W-1	347	2000	Air	Waste collection
V-16	304 L	50	None	Vacuum surge tank
F-11	Nickel	-	None	Filter
M-1	347	10	Agitator	Make-up
M-2	347	20	Agitator	Make-up

1.5. Source Encapsulation Equipment

Two inert gas pressure welders are remotely operated in Cells 4 and 5 of the SFF. These welders are versatile in their design to allow the encapsulation of a variety of capsule materials. The welding is accomplished under helium or argon pressure, and the capsule holder forms a chill block with water coolant to remove excess heat.

Ultrasonic cleaners are located in Cells 4 and 5 for cleaning capsules to smear tolerances. The normal decontaminant required in the cleaning process is detergent or weak acid.

Helium leak detection equipment is operated remotely to test the encapsulated source for minute leaks.

1.6. Auxiliary Equipment

A chilled water system[2] with a capacity of five tons is used for all in-cell cooling. The chiller consists of a five-ton compressor unit with an automatic process water condenser. The chilled water is recirculated through the cell equipment by a dual pump system. In case of power or equipment failure, process water can be passed through the cell equipment to the process waste system on a one pass basis. An automatic make-up tank supplies the necessary water for the chilled water system. The chilled water is sampled on a weekly basis for alpha contamination to check the process coils and jackets for leaks.

The process vacuum system services all cells and provides the mode of solution transfer. The vacuum pump is located in Cell 6. A filter system of stainless steel Neva Clog[3] pre-filters and CWS absolute filters removes particulate matter before air is discharged into the Isotope Area off-gas system. The vacuum pump is started manually when solution transfers are required. A 50-liter surge tank is located on the main vacuum header and provides an adequate catch vessel for the maximum solution volume handled in the SFF cells. All vacuum transfer vessels have temperature sensitive probes which signal high liquid level in the vessel and automatically turn off the process vacuum to that vessel.

A chemical make-up area[4] is located on the second level of the SFF building and contains two small stainless steel vessels. These vessels are used for chemical makeup for solution addition to the in-cell vessels. The make-up tanks (Fig. 3.1.1) drain through flexible lines to funnels connected to pipes leading to vessels in the cells. The lines from the funnels have

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[2] Appendix No. 19.

[3] Appendix No. 17.

[4] Appendix No. 16.

valves located in the operating area which are opened after the funnel is partially filled with liquid. The transfer line from the funnels terminates in the cell with a stainless steel ball joint. From this point, a tygon line is placed in the appropriate funnel for addition to the process vessel. A valve on the in-cell funnel is operated by manipulators to allow solution to flow into the vessel.

A feed transfer station located at the rear of the operating cell contains the necessary services for connecting the feed solution casks. The station consists of a stainless steel pan with a drain to SFF hot waste tank. The carrier is placed on the pan and chilled water connectors are attached to the cask. The top of the carrier is sealed with plastic to a glove box containing flexible stainless steel connectors for attachment to the Cell 1 tanks, off-gas, and cell ventilation. Chilled water is supplied for cooling the cask during transfer operations. All materials going to or from the glove box are sealed in plastic.

A manipulator decontamination station is located at the rear of the cells for cleaning and repairing manipulators. The station consists of a plastic shield connected to the cell ventilation system and a stainless steel drain pan connected to the hot waste system. An SFF manipulator[5] is sealed in plastic for cell removal and transferred to the decontamination station. The slave end of the arm is sealed in the station, and all decontamination and repair operations are accomplished through glove ports and bag-out stations.

A standard wet cell battery is located in the operating area to supply an emergency source of DC voltage to signal alarms in case of power failure. Emergency lighting is supplied by individual wet cell lanterns which are actuated by a failure of the 110-v AC circuit.

2. CONTAINMENT

2.1. Cell Containment

The containment of alpha activity in the SFF cells is accomplished by a stainless steel liner, penetrated by service lines, process lines, and conduit which are welded to the liner. All access holes for lighting, etc., are sealed to the liner with teflon gaskets, and transfer stations have air locks between cells. The air flowing into the cells (Fig. 2.1.1) is filtered by a CWS filter; a backflow preventer has been installed to prevent a blowout of activity due to cell pressurization. The effluent air passes through CWS filters (a spare CWS filter is available for routine filter changes). The manipulators have a primary seal of urethane booting material and a secondary seal formed by an additional plastic boot and the wipers inserted in the manipulator barrel.

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[5]Appendix No. 2.

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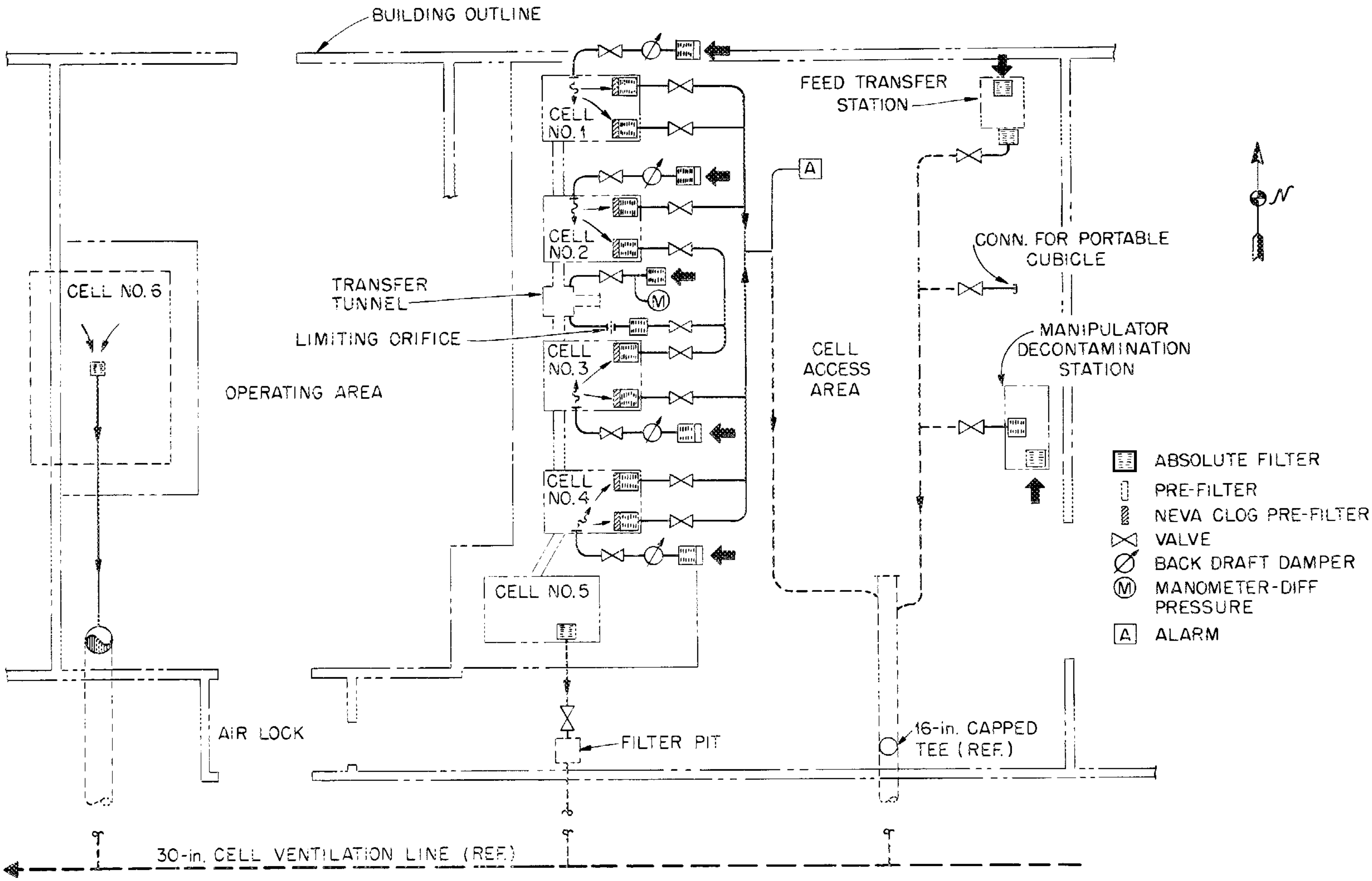

Fig. 2.1.1. Cell Ventilation Schematic, Bldg. 3028

All contaminated waste and samples are removed and sealed through a bag-out station which is separated by an air lock from the main cell bank and separately ventilated.

All spare lines are capped on the inside and outside of the cell. Tubes leading to the cell ventilating pressure gages have absolute filter cartridges installed inside the cell.

2.2. Building Containment

The portion of Building 3028 (Fig. 2.2.1) which houses the SFF cells was sealed by cocooning all outside surfaces of the building. The pressure in the building is reduced to less than 0.3 in. of water 20 seconds after the damper on the cell ventilation duct is opened by a signal from alpha constant air monitors.

All normal entries to the building have air locks for lift truck and personnel access. Emergency exits are located on the second, third, and fourth levels of Building 3028 for personnel exit in case of fire or explosion. These exits do not have air locks but are sealed from the inside and locked on the outside to prevent loss of containment. The crash bar door operator meets all Fire Department regulations concerning emergency exits.

All doors are gasketed to meet leakage standards, and personnel air inlets are supplied with automatic closures which are actuated by the containment signal. The building air supply is normally passed through roughing filters before discharge to the atmosphere.

Interior partitions are provided to separate the operating areas from possible contaminated areas and air conditioning has been installed in the manipulator area for personnel comfort.

In the event of an accidental release of alpha activity into the building interior from the cells, all building openings are closed automatically. The emergency cell ventilation exhaust duct dampers are thrown to full open position and the interior of the building is exhausted to a vacuum of 0.5 in. of water. The signal which actuates the automatic devices is received from a two out of three alarm circuitry from three alpha CAM's. During the containment period, the cells are controlled at >1.0 in. of water vacuum with reference to the building interior. All air exhausted from the building during containment is passed through roughing and absolute filters before discharge to the stack.

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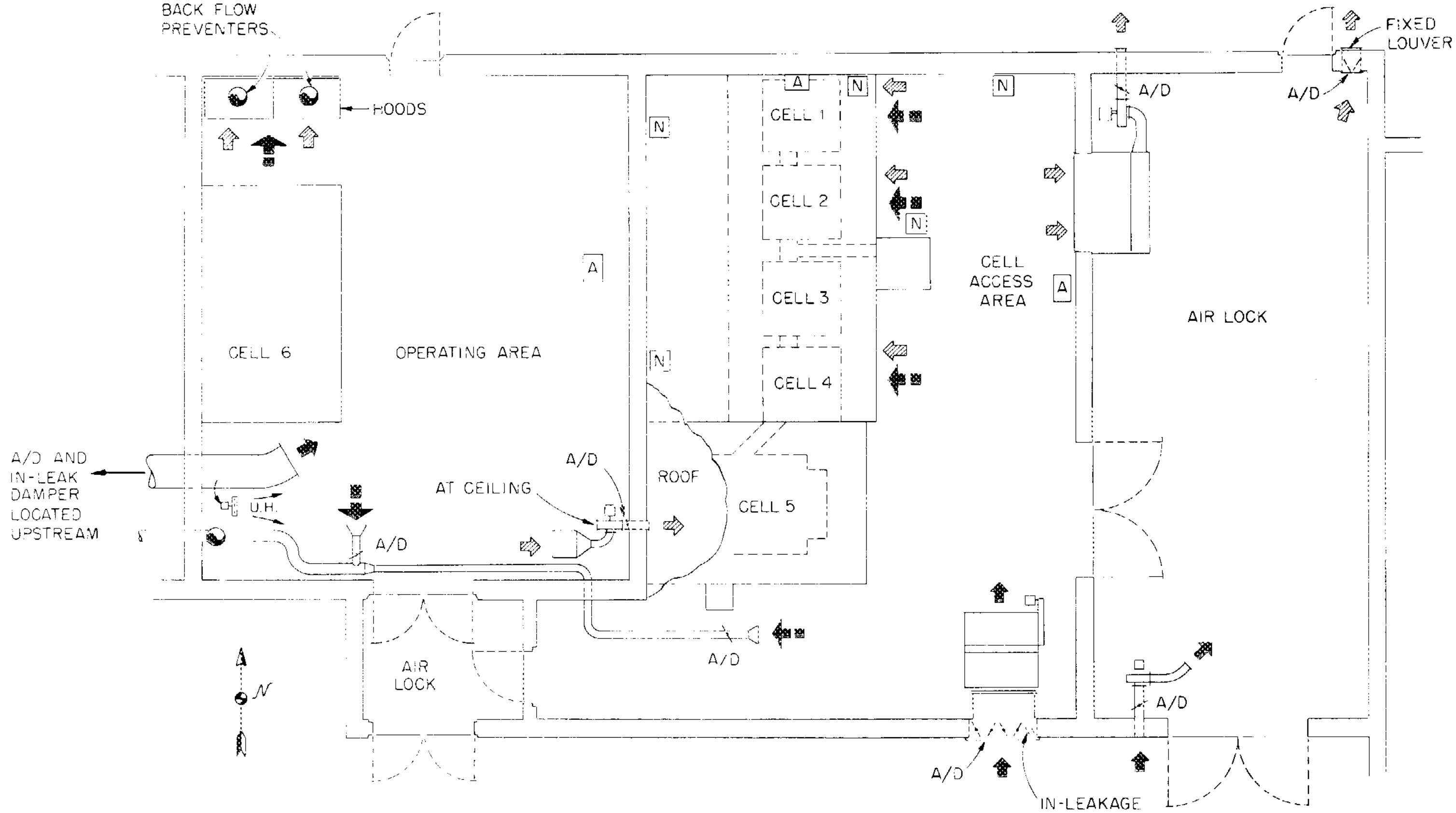

AIR FLOW IN NORMAL CONDITION
AIR FLOW OUT NORMAL CONDITION
AIR FLOW OUT EMERGENCY CONDITION
RECIRCULATED AIR, UNIT HEATER
A/D AUTOMATIC DAMPER
[A] ALPHA AIR MONITOR, Q-2340
[N] NEUTRON MONITRON

Fig. 2.2.1. Air Flow, Bldg. 3028

3. OPERATIONS

3.1. Chemical Process

A purified aqueous solution of curium is received at the SFF from the Curium Recovery Facility (Building 4507) in a shielded cask which is then connected to the SFF process equipment for transfer of the solution. The unit chemical process accomplished in the SFF cells is precipitation. Operations such as evaporation, decantation, filtration, and dissolution can be performed with the installed equipment. Since the SFF is made up of manipulator cells, most chemical processes can be accomplished in relatively small equipment.

Curium will be precipitated as the oxalate in Cell 1, which contains two stainless steel vessels for solution transfer and one precipitator vessel (Fig. 3.1.1). All tanks and the solution filter are jacketed and supplied with chilled water for coolant of the process solution.

The normal operating volume of the precipitator is 10 liters and the maximum activity level in this tank is 50,000 curies of Cm^{242}. Under normal operations, 10,000-curie batches of Cm^{242} are processed through this vessel. The process consists of adjusting the pH to 1.0 by the addition of small increments of 70% HNO_3. A solution of 1.5 M oxalic acid is then added and the resulting solution digested for a period of time with frequent checks on the pH. All pH determinations are made with in-cell equipment.[6]

After digestion is complete, the slurried solution is filtered through a stainless steel filter to collect the precipitate. The filtrate is collected in a vacuum receiver tank, sampled by in-cell sampling equipment, and transferred to the SFF collection tank (W-1) under the direction of supervision after the analysis has been received.

The batch operation continues until all of the solution in the transfer feed cask is converted to a precipitate in the filter vessel.

3.2. Sampling

Samples of product and waste solutions[7] will be taken by an in-cell vacuum sample system and drained into standard glass sample bottles. The bottles will be capped, transferred to the loadout station, inserted into a plastic bag inside the sample carrier and the plastic is sealed and cut. The carrier lid is gasketed and bolted to the carrier which is then cleaned to smear tolerance for delivery to Building 3508 laboratory.

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[6] Appendix No. 3.

[7] Appendix No. 4.

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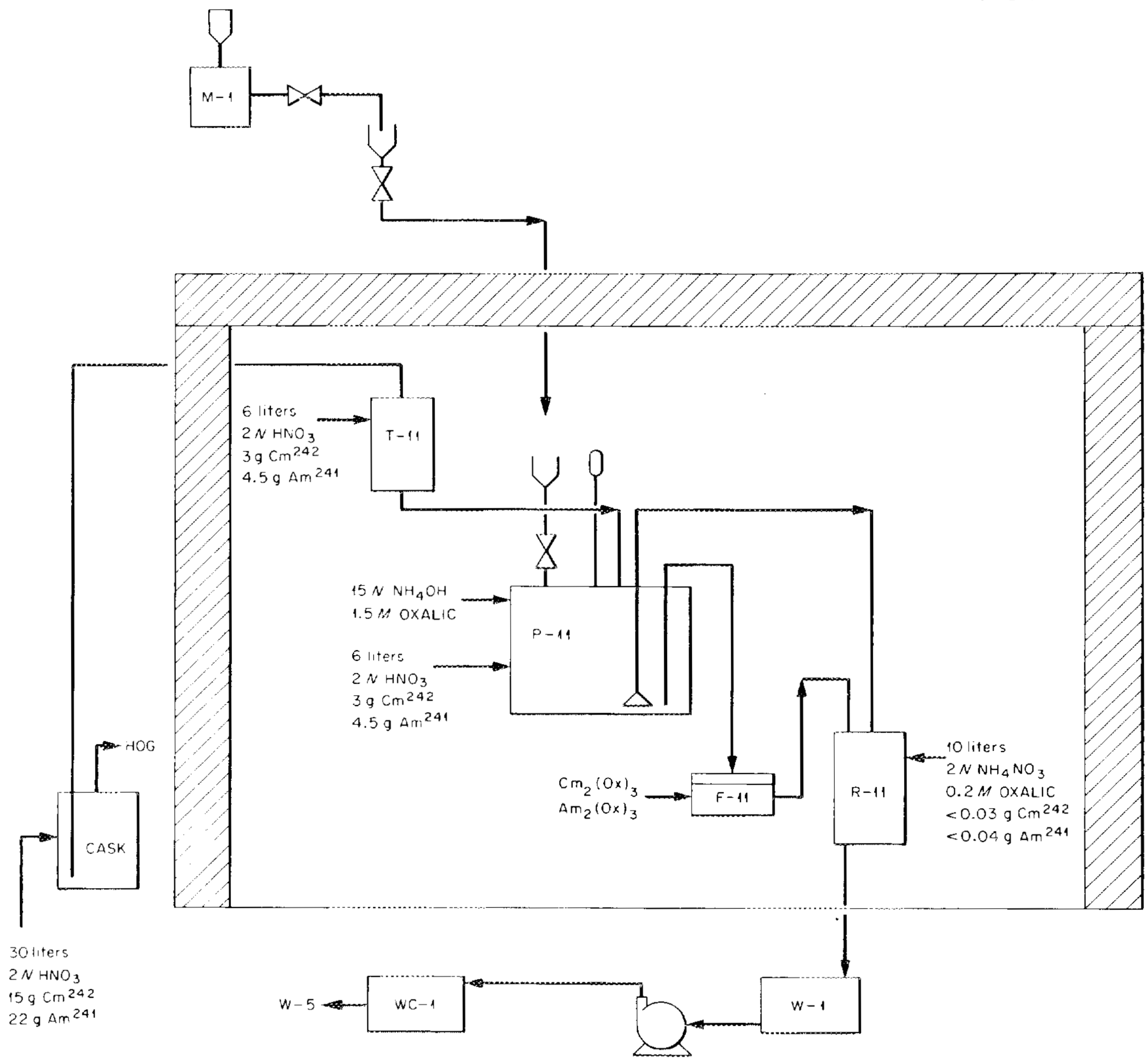

Fig. 3.1.1. SFF Chemical Flowsheet

3.3. Calcination

Calcination of the curium oxalate takes place in a small tube furnace at a temperature of 1000°C. After calcination, the filter is removed with manipulators and transferred to a chill block for in-cell movements. The calcined powder is transferred to a calorimeter for product determination.

3.4. Pelletization

After calorimetric determination of the thermal output of the product, the powder is transferred to Cell 2 for blending and pelletization. A calculated quantity of matrix material is added to the product and blended in a "V" type blender with a water-cooled jacket. The blended powder is mechanically measured into a split die body cooled with chilled water and placed in a hydraulically operated press. The pellet is pressed under 29,000 psi pressure and immediately ejected into a chilled container. The pelletization is continued until sufficient pellets are made to meet customers specifications concerning thermal output of the final source.

3.5. Sintering

The sintering of the pelletized material is accomplished in a graphite resistance furnace at 1725°C, measured by an optical pyrometer. The furnace has a water-cooled shield to remove the excess heat of the resistance furnace. The power supply for the furnace consists of a power pack located in the manipulator area which will be manually operated to adjust the temperature of the furnace. A helium purge system supplies an inert atmosphere to the furnace during sintering operations.

3.6. Encapsulation

The sintered product is sealed in capsules by welding in an inert atmosphere. The welding chamber is leak tight and can be operated under vacuum or pressure, depending on the welding requirements. A water-cooled block maintains the capsule material at a safe operating temperature. The power supply for the welders is located in the manipulator area for manual adjustment of the welding conditions.

3.7. Operating Safeguards

The operations at the SFF are accomplished by standard operating procedures[8] and any deletion, omission, or addition to these procedures without approval of the building supervisor is considered grounds for disciplinary action. The usual chemical plant safety practices[9] are followed and specially applicable regulations are posted.

The operators follow a standard operating procedure book located at the panelboard and record critical data on a process data card which is filed for each batch processed. The batch data card is used for inventory control as well as a check system on the actual operations. These cards remain in the inventory control system until all analyses have been received and several batches have been combined for further processing. The completed cards are filed for one year before destruction.

Operating procedures are continually changing due to minor changes in the feed material and process improvements. These changes are reviewed by the building supervisor and a chemist from the Isotope Development Department and must be approved by the Division Radiation Safety Control Officer. If a procedure change is approved, the operating procedure at the panelboard is corrected and written notification is recorded by the building supervisor in the "SFF Instructions Log".

Decontamination operations differ depending on the equipment involved, but a standard decontamination solution procedure is used to prevent the faulty mixing of chemicals during this period. The flow of the decontamination solutions is determined by the building supervisor and all jets and valves leading to critical areas are blocked and tagged at the panelboards.

Shift tank inventories and shift checks are taken each shift[10], and the recorded data are studied by the incoming supervisor to assure continuity of operations. Additional data are recorded in the Operations Log Book by each shift supervisor[11] for a written record of all operations taking place at the SFF. The completed log books are filed for future reference.

A building check sheet is completed once a day for a record of data on the building services and auxiliary equipment. All stored chemicals used in the process are regularly inventoried.

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[8] Appendix No. 5.

[9] Appendix No. 6.

[10] Appendix No. 7.

[11] Appendix No. 8.

4. PERSONNEL PROTECTION

4.1. Personnel Control

The number of people normally occupying Building 3028 and adjacent facilities are listed in Table 4.1.1.

Table 4.1.1. Building Occupancy

Building No.	Number of People: Week Days	Number of People: Nights and Weekends
3028	3*	2
3047	30*	0
3029	8	0
3028-W	1	0
3039 Area	1	1
3042	100*	12
3030	3	0
3031	2	0
3032	2	0
3033	5	1
3038	10	3
3037	35	1

*Additional scientific and maintenance personnel will vary.

4.2. Personnel Exposure

The SFF cells are designed to give <1 mrem/hr n and γ dose to operating personnel under full scale operating conditions. The expected exposure from normal operations will not exceed 100 mrems/wk.

4.3. Exposure Possibilities

The greatest amount of exposure comes from decontamination work or accidental release of contamination. The decontamination exposure is organized under standard procedures as listed in the Zoning Procedure for the SFF[12] and the Procedure for Personnel Entry to SFF Cells[1].

[12] Appendix No. 9.

All samples and solid waste material are sealed in plastic bags and transferred from the manipulator cells into a top loading carrier which has no reading greater than 200 mr/hr at contact. The normal exposure per person for this type of work is <10 mr/wk.

Cell access doors are locked and entrance must be approved by Health Physics and SFF supervision. Entrance to the SFF cells is controlled by the Zoning Procedure for the SFF[12] and Procedure for Personnel Entry to SFF Cells[1].

All normal entrances to the building are by way of air locks. Fire excape doors, which do not have air locks, are used for emergency exits only and cannot be entered from the outside.

4.4. Radiation and Contamination Controls

Radiation Monitrons

Four neutron monitrons are located at strategic points in the building for detection of neutron radiation (Fig. 1.1.2). The areas monitored are: 1) feed transfer station, 2) waste station, and 3) manipulator area. All monitors are connected to a central alarm and panelboard system which is answered by supervision and Health Physics when the alarm signal is sounded. Monitors are also equipped with local alarms to notify personnel of hazardous conditions. All monitron units are checked for operation on a daily basis.

Constant Air Monitors

Three alpha constant air monitrons with local and central alarms are located in the critical areas which could be affected by an alpha air count (Fig. 1.1.2). One unit is always available for movement to take direct reading during decontamination and maintenance work. If an air count of 10 times MPC_a is collected for 10 minutes and recorded on two out of three air monitors, an alarm will sound and actuate the building containment system. All constant air monitors are checked for operation daily, and the containment system is checked on a weekly basis.

Radiation and Detection Equipment

Portable alpha counters, Victoreens, and cutie-pies are located at strategic locations in the building, and all operating personnel are trained in the use of these instruments.

An alpha survey meter is located adjacent to the normal building exit; all personnel are required to check themselves before leaving the building area. A probe is also available for checking beta and gamma contamination on the outer garments.

The Health Physics office in Building 3047 contains an alpha smear counter, a beta-gamma smear counter, high-level radiation probes, portable disc air samplers, Hi-Vol air samplers, cutie-pies, neutron and alpha survey meters, and Victoreens. All operating personnel are trained in the use of this equipment.

Emergency Equipment

Emergency assault mask cabinets are located in all operating areas for immediate use in case of a high air count in the building. Individual gas masks with prescription safety glasses have been issued to personnel who must have prescription glasses for vision while wearing the masks.

An emergency cabinet located in the east air lock contains an air line mask system, plastic suits, rubber suits, chem-ox gas masks, gloves, safety lines, lanterns and hard hats.

An emergency evacuation procedure[13] is posted in the building, and all personnel have been informed of their duties and procedure. The evacuation route is illustrated on Fig. 1.1.1.

Process Instrumentation

Process vessel services are pneumatically operated from graphic panelboards and all temperatures are recorded and alarmed. The pressures of the vessels are measured by in-cell gages using a system which eliminates the possibility of process solution backup in instrument lines outside the contained cell area. The solution level is controlled by thermal probes on all vessels plus a differential pressure transmitter system on P-11 tank.

Cell ventilation, off gas, chilled water pressure, and cell shielding water are instrumented to alarm at the panelboard. All alarms are preset to give an adequate lead time for manual adjusts to the system.

5. WASTE DISPOSAL

5.1. Liquid Waste

The normal discharge to the hot waste system will be 1000 gal/yr; the discharge to the process waste system will be negligible.

Low Level Radioactive Waste

Low level radioactive wastes consisting of cell floor washings, cell decontamination solutions, and process vessel condensate are collected in a stainless steel waste collection tank, W-1. The normal volume of this type of waste is 10 gal/day, and the activity level is 1 to 100 curies of mixed Am^{241}-Cm^{242} per day. After these solutions are sampled and analyses are received, the solutions are pumped[14] to WC-1 tank on the ORNL tank farm when the tank liquid level reaches 60% of capacity. If a tank bursts in the

[13] Appendix No. 10.

[14] Appendix No. 11.

cells, the contents drain to the W-1 tank. If recovery is desirable, the solution is transferred to the feed cask for recovery operations at Building 4507. If recovery is not feasible, solution is transferred to WC-1 tank and then to W-5 tank in the ORNL tank farm.

Intermediate Level Radioactive Waste

The intermediate level radioactive waste solutions consist of the waste stream from the normal process operations plus decontamination solutions. These solutions are collected in a stainless steel tank (W-1), sampled for radiochemical analysis, and then pumped to WC-1 tank in the ORNL tank farm. The normal volume of these solutions is 10 gal/day and the average activity is 500 curies of mixed Am^{241}-Cm^{242} per operating day. These solutions are generally acidic from oxalic acid process solutions. The SFF operations which produce these solutions will be in operation 100 days per year.

High Level Radioactive Waste

There are no waste streams leaving the SFF that could be considered as high level. If a product solution was inadvertently transferred to the W-1 collection tank, the analysis of product streams and the waste tank would indicate the loss and the solution would be recycled for recovery.

Organic Waste

There are no organic solvents used in the SFF chemical process. A possible source of organic material is the hydraulic fluid used for remote operation of the press. This solution could discharge in the cell from a ruptured line and would drain from the cell to W-1 tank. The volume would be less then 1 gal and would not create an operating problem or a hazard.

Process Waste System

The process waste system collects the solution from building sinks and floor drains. This system has very small flow, and possible contamination in this system could originate from decontamination of operating area floors.

The chilled water recirculation loop provides coolant for all process vessels and condensers and is serviced by a 5-ton refrigeration unit. The purpose of this system is to contain any radioactive leak from process vessels or coils within the confines of the building piping and to supply coolant for the high thermal output of curium process solutions and solids. If a leak occurs, the system is flushed to the ORNL hot waste system (WC-1), and thus no radioactive solution enters the process waste system. The second advantage to this system is the conservation of process water which normally is discharged to the process waste treatment plant for further processing.

The steam condensate from process vessels is condensed and collected in the ORNL WC-1 collection tank. If a radioactive leak occurs, the solution is discharged to the ORNL tank farm for disposal.

Storm Sewer System

The storm sewer system receives all roof drainage, building heating condensate, and cooling water to the freon condenser of the chilled water unit. Since all of these sources are non-radioactive, the only possible contamination would come from an outside source and settle on the building roofs. The normal operation of the chilled water unit requires the cooling water to go through the freon condenser system directly to the storm sewer. There is no possibility of contamination in this system.

5.2. Gaseous Waste

Off-Gas System

The off-gas system at the SFF supplies a vacuum to all vessels in the plant cells. The vacuum is controlled in Cell 6 by a pneumatically operated valve which automatically adjusts the off-gas to 6 to 8 in. of water vacuum on the process and waste collection vessels. The normal flow through this controller is 50 cfm, and the gases present are CO_2, oxides of nitrogen, and hydrogen. The particulate matter entrained could be any radioisotope in process.

The off-gas stream flows through a stainless steel prefilter[15] and an absolute filter for final cleanup. At this point, off-gas flow is discharged to the ORNL gaseous waste disposal facilities.

A bypass filter system is used to continue filtration during the replacement of used filters. The contaminated filters are removed by direct maintenance[16] sealed in plastic and transferred to a shield for removal to the burial ground.

The ORNL off-gas system is provided with steam turbines which automatically continue the off-gas flow in case of power failure. The SFF off-gas control system is pneumatically operated and is designed to open in case of an air failure.

Cell Ventilation System

The cell ventilation system for the Isotope Area draws a vacuum of 1.0 to 2.0 in. of water on the manipulator and off-gas cleanup cells. The normal volume of air swept through this system is 300 cfm.

The filtration unit for the cell ventilation air is located inside each cell and consists of a stainless steel Neva Clog roughing filter and a

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[15] Appendix No. 12.

[16] Appendix No. 13.

CWS filter[17]. The filters are gasketed and sealed in place by a locking device to prevent bypass leakage. The cell ventilation air is discharged into the Isotope Area cell ventilation system and the air is again filtered in the central filter facility before discharge to the stack.

A bypass system is installed on the Isotope Area cell ventilation filter pit. This is an operational bypass to give a filtered vacuum on the SFF cells during filter changes in the main filter pit.

Building Ventilation System

The building ventilation system provides air for personnel and is regulated to equal the air being removed by the cell ventilation system. If the building air becomes contaminated, a signal from the alpha constant air monitoring system closes the inlet building air supply and opens supplementary cell ventilation ducts which exhaust the building air to the Isotope Area filter pit.

5.3. Solid Waste

High Level Solid Wastes

High level solid wastes from SFF consist of materials and equipment which have become contaminated during use in the manipulator cells. The material or equipment[18] is washed in the manipulator cell, placed in a plastic bag, inserted in a 1-gal tin can, sealed with a lid, sealed in plastic and loaded from the cell into a top-loading shielded carrier. The carrier is removed to the burial ground by riggers under the surveillance of a Health Physics representative. When the carrier is returned to the building, it is checked for contamination and cleaned to H.P. tolerances.

Large equipment such as laboratory balances, furnaces, presses, scales, stainless steel filters, and lab centrifuges are decontaminated in the cell before they are sealed in plastic for disposal. If the equipment is to be discarded, a Dempster Dumpster lined with stainless steel is used to remove the material to the burial ground. If the equipment can be recovered by further decontamination, it is taken by operating personnel to the manipulator decontamination cell where it can be further decontaminated with low exposure to personnel.

Low Level Solid Wastes

The low level solid wastes consist of contaminated materials used in manual decontamination procedures. This material normally reads <100 mr/hr and

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[17] Appendix No. 14.

[18] Appendix No. 15.

is placed in plastic-lined hot cans located in strategic areas in the building. When a can is full or the radiation level of 6 mr/hr is exceeded, the plastic bag is sealed with tape and removed to the "hot" Dumpster. The Dumpster truck removes the material to the burial ground on a daily basis. The returning "hot" Dumpster is checked for contamination by Health Physics and approved for further use.

A daily survey of the "hot" Dumpster is made by the Health Physics representative, and supervision surveys the suspected containers during shift decontamination operations.

6. PROCESS HAZARDS

6.1. Chemical Reactions

The precipitation[19] of curium oxalate will be limited to 10,000 curies of Cm^{242} or 350 watts of thermal heat per batch.

A total of 3.0 g of Cm^{242} and 4.5 g of Am^{241} is precipitated from a solution containing 0.05 to 0.1 N free nitric acid and 0.1 to 0.15 M ammonium oxalate. The equation for the reaction is as follows:

$$2Cm^{3+} + 3(C_2O_4)^{2-} + 9H_2O = Cm_2(C_2O_4)_3 \cdot 9H_2O$$

The precipitation is made from a final volume of 10 liters, and 0.05 moles of oxalate will be required to precipitate the Am^{241} and Cm^{242}. An excess of 1.0 to 1.5 moles of oxalate is provided to replace the oxalate destroyed by radiation and to obtain more complete precipitation of Am^{241} and Cm^{242}.

Carbonate is formed by the radiolytic decomposition of oxalate ion, and the pH of the solution will rise slowly if processing must be discontinued due to temporary operating difficulties. To readjust the pH of the solution to 0.05 to 0.10 N in free acid, nitric acid (16 N HNO_3) is added in 15-ml increments to the slurry. The temperature of the slurry is maintained at 50°C in order to promote the liberation of CO_2 gas from the solution. A maximum of 2.0 liters of CO_2 gas could be liberated for each nitric acid addition to the solution. Since CO_2 is much less soluble at 50°C than at 20°C, the carbonate neutralization is carried out at 50°C to prevent inadvertent foaming of the solution which could occur if the solution were neutralized at 20°C and subsequently heated to 50°C.

The non-condensable gas will be formed at a rate of 0.02 liters/min per 10,000 curies of Cm^{242} oxalate slurry. The rate of gas formation can be a factor of 10 higher, if 1.0 N nitrate is not maintained in the solution. It can be assumed that all this non-consensable gas is hydrogen.

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[19] Appendix No. 20.

6.2. Explosion and Fire Potential

Two possible sources of combustible or explosive conditions exist in the SFF cells. The major source of combustible materials would arise from swabs, plastic bags, and miscellaneous equipment transferred into a cell for clean-up. These materials will be closely controlled by the SFF supervision and removed from the cells during normal operations.

The explosive potential would arise from the evolution of hydrogen gas from the radiolytic decomposition of aqueous solutions. This gas is diluted well below its lower explosive limit of 4% by the vessel off-gas system. The estimated air flow through each process vessel in the building is 280 liters/min. This value varies according to the type of vessel in question, but under normal conditions gives more than adequate dilution for removal of hydrogen by radiolytic generation. The calculated gas evolution during chemical processing is listed in Section 6.1.

A shipment of feed material[20] arrives at the SFF approximately 4 hr after loading at the CRF. The container is sealed to prevent the release of small quantities of hydrogen gas being evolved by the radiolytic decomposition of water. The pressure will be vented to off-gas immediately upon arrival at the SFF.

6.3. Pressure Hazards

The operational procedure requires 6 in. of water vacuum in the process vessel which is more than adequate to control the gas released by the described reactions.

If an operational error is committed and the chemical addition is increased, pressurization of a vessel could result but the off-gas system would continue to remove the bulk of the gas liberated. The remainder would vent to the cell ventilation through the open valve on the solution addition line. If extremely high pressure were formed, radioactive solution could be forced through sampler dip legs and would be discharged in the cell. The vessel dip legs would discharge to the cell floor or adjacent vessels in the cell. The liquid level lines would discharge into an instrument cubicle which is contained in the cell ventilation and drainage system.

7. MAXIMUM CREDIBLE INCIDENT

The maximum credible incident at the SFF would be the explosive release of (1) 15 g of Cm^{242} and 25 g of Am^{241}, or (2) 150 g of Cm^{244} in solution from

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[20] Appendix No. 18.

the precipitator vessel. This could occur if the hydrogen content reached the explosive limit and was detonated by an electrical discharge.

The results of such an event of activity release are given in Table 7.1. Using the methods outlined in ORNL-TM-346[21], a radioactive release involving Cm^{242} and Am^{241} to the 3039 stack, assuming a cell ventilation absolute filter effluent aerosol concentration of 0.14 mg/M^3, would contaminate a downwind area of approximately 0.1 sq miles to a level of less than 100 d/min.cm^2 β-γ and 30 d/min.cm^2 alpha. This release of 2.1 μc of Cm^{242} to the environment would result in a maximum downwind dose of less than 0.4 mr.

A stock release of 1.1 μc of Cm^{244} would result in a maximum downwind contamination area of less than 0.03 sq miles and a maximum downwind dose of less than 1 mr.

The maximum credible release to the secondary containment area would involve the discharge of 9.9 ft^3 of an aerosol at a concentration of 10 mg/M^3 which contained 3 μc of Cm^{244}. This would result in a pseudo two-minute dose to personnel before evacuation of 29 rems.

Table 7.1. Activity Release From Non-Critical Event

Cell Ventilation System Release	Am^{241}	Cm^{242}	Cm^{244}
Total amount released through cell ventilation system, curies.	3.4×10^{-6}	2.1×10^{-3}	1.1×10^{-3}
Maximum average downwind dose from cell ventilation release, rems.	9.0×10^{-6}	3.4×10^{-4}	0.9×10^{-3}
Distance of dose downwind from stack, M.	1750	1750	1750
Maximum area contaminated (miles)	17.5×10^{-5}	1.1×10^{-1}	2.6×10^{-2}
Explosion Release			
Total quantity suspended, curies	2.4×10^{-4}	15.0×10^{-2}	3.6×10^{-2}
Concentration c/M^3	7.5×10^{-5}	45.5×10^{-3}	1.1×10^{-2}
Building Release			
Total amount released into Bldg., curies.	2.1×10^{-5}	1.3×10^{-2}	3.1×10^{-3}
Concentration, c/M^3	1.5×10^{-8}	9.0×10^{-6}	2.2×10^{-6}
Pseudo two minute dose to personnel from aerosol release, rems	0.3	11	29

[21] E. D. Arnold and J. P. Nichols, "Hazards Analysis of Fuel Handling Facilities," ORNL-TM-346, August 24, 1962.

APPENDIX NO. 1

SFF Cell Entry Procedure

I. Cell Danger Zone

Definition: An area where high level radiation and contamination can be expected or is expected to exist.

SFF Cell Danger Zones

1. Manipulator Cells 1, 2, 3, 4, and 5
2. Service Cell 6
3. The tops of all cells
4. The roof of Building 3028
5. Cask solution transfer facility and decontamination facility

II. Removal of Water Shielding Tanks (Cells 1, 2, 3, 4)

1. Before water is drained from the shielding tanks, all unnecessary equipment and debris must be moved to adjoining cells.

2. Supervision will check all connections prior to draining. Only the tank in question must be allowed to drain.

3. The presence of Health Physics is required during the draining process. H.P. checks for radiation (both gamma and neutron) during the draining and if any unusually high radiation is detected, the draining is to be stopped and further decontamination will be done. H.P. will also check radiation levels at the adjoining cells to insure that other banks are not draining.

4. Remove the empty shielding tank.

5. H.P. checks the back of the cell for radiation.

6. Build a plastic tent over the back of the cell. This area is declared a "contamination" zone.

7. Obtain RWP. Specify plastic suit, rubber gloves (2 pr), bootees (2 pr) and necessary H.P. equipment.

8. Remove the back plate and decontaminate through the glove ports.

9. If possible, repair work will be done through the glove ports. If this is not possible, the glove port plate will be removed (after thorough decontamination) and cell entry will be made.

III. Cells 5 and 6

These cells are entered in the standard manner through doorways. These are concrete cells and they have no water shielding.

IV. Entry Procedure

Entry to a Danger Zone requires that the following items be completed before personnel shall enter the area:

1. A survey by H.P. using proper equipment for determining personnel exposure.

2. Radiation Work Permit signed by supervision and Health Physics.

3. Personnel shall wear the following protective clothing and equipment:

   a) Coveralls
   b) Dosimeters (2) that will be read before, during, and after entry to a cell.
   c) Pencil meters (2)
   d) Film badge
   d) Film ring to be worn on the hand normally used for hand operations.
   f) Neutron packet attached to back of hand.
   g) Plastic suits with an air hose. If it becomes necessary a liquid air pack and a one piece suit can be used. If a non-plastic suit area requires a gas mask, all clothing will be taped and no part of the body shall be exposed.
   h) Rubber gloves (2 pr)
   i) Plastic bootees (2 pr)

4. A timing device shall be set for the determined work time and shall be equipped with a mechanical or electrical alarm.

5. An observer is required for entry into a Danger Zone and he shall be in a location where he can render immediate air or call for assistance if required.

6. A monitor device shall be placed in the Danger Zone with an observer or an alarm unit located outside the area to monitor sudden changes in radiation level.

7. SFF personnel will enter a Danger Zone with a portable neutron detector in their possession.

V. In-Cell Procedure

1. Do not remove anything by hand. Use tongs, pliars, extended brushes, or any other device which will keep the hands and body in radiation fields less than 5 r/hr.

2. Check all suspicious material with the portable neutron detector.

3. Place the portable neutron detector in a position where it can be read at a glance.

4. If you move a piece of material with one hand, check radiation with the portable neutron detector in the other hand.

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

VI. Departure Procedure

Personnel leaving a Danger Zone shall follow the procedure outlined below:

1. When the observer or the alarm signals the end of the working time or changing radiation levels, the employee will immediately stop work and leave the cell by the shortest and safest route.

2. When the employee reaches a designated area, the observer will wash the contamination from the plastic suit with water spray.

3. The employee will then enter a Contamination Zone and remove the contaminated protective clothing. He will move from the contaminated area to a regulated area as he removes the final piece of protective clothing.

4. The employee will then be surveyed by designated personnel and his dosimeter reading recorded on the work permit.

5. The employee will proceed with any personal decontamination required and will not be assigned further duties until he has met all the requirements concerning body contamination.

VII. Replacement of Water Shielding Tanks

After completion of in-cell work, the cell will be placed in operation by the following procedure:

1. Cover the glove ports by replacing the back plate on the cell.

2. H.P. check for contamination in the plastic tent area. Clean if necessary before removing the tent.

3. Remove the plastic tent.

4. Place the empty shielding tank in position at the rear of the cell.

5. Hook up the water connections. Supervisor will personally

inspect this and be sure the hook-up is done properly. If the connection is made properly, an alarm will sound (low level make-up tank) indicating that the make-up tank is sending water to the shielding tank.

6. When the tank is full, the cell can be placed in service again.

7. H.P. checks the back of the cells thoroughly for contamination.

APPENDIX NO. 2

SFF Manipulator Removal Procedure

I. Preparation

1. Mount an alpha CAM on the cell top near the work area.
2. Cover the tops of the adjoining cells with paper.
3. Set up facilities for plastic suits. Plastic air line suits will be worn by all personnel in the work area.
4. Move contaminated material in the cell to adjoining cells.
5. Set up heat sealer on the cell top.
6. The presence of H.P. and Supervision is required during the removal.

II. Manipulator Removal

1. Disconnect the snap-tite connectors on the water lines of the tank that is to be removed.
2. Connect a hose with a snap-tite connector to the drain line of the tank.
3. Drain the tank. H.P. monitors this operation and checks adjacent tanks to make sure they aren't accidentally draining.
4. Using the crane, remove the tank and place it on paper on top of one of the adjacent cells. H.P. surveys the work area after the block has been removed.
5. Check the removal bag. Make sure it isn't torn.
6. Connect the crane to the arm and begin removing it from the cell. Make sure the removal bag does not rip during this operation. H.P. monitors the removal.
7. When the arm is free from the cell, heat seal the bag between the arm and the cell.
8. Cut the bag at the seal (using the hot wire) so that the arm is inside the bag and the cell is still sealed.
9. Using the sealed portion of the bag that is connected to the cell as a glove, disconnect the old boot and allow it to fall into the cell.

10. Move the arm to the manipulator decontamination facility for any decontamination or repair that may be necessary.

11. H.P. checks personnel and area for contamination.

III. Manipulator Installation

1. Check that a new boot is ready for installation.

2. Place the new boot in position at the opening of the cell.

3. Using the boot as a glove, reach in and release the removal bag stub and allow it to fall into the cell.

4. Place the boot "O" ring in the boot position.

5. Allow the boot to be pulled into the cell by cell ventilation. The boot is now hanging from its "O" ring.

6. Place the plastic sleeve that is to be used as a removal bag in position.

7. Insert the arm through the removal bag and into the boot.

8. Tape the open end of the removal bag to the manipulator barrel.

9. Position the barrel of the manipulator in its groove and place the removal bag around it so that it will not be ripped by the top block.

10. Insert the slave fingers into the boot fingers.

11. Replace the top block.

12. Refill the shielding block with water.

13. H.P. checks personnel and area for contamination.

APPENDIX NO. 3

SFF pH Meter Operation Procedure

1. With power off, the meter should read pH 7.00. (See Note 1 at end of procedure if this reading is off.)

2. Turn the zero-measure switch to zero. Connect the pH meter to the power line (power is now on).

3. Plug in electrodes and immerse them in a standard buffer solution.

4. Turn the FUNCTION switch to the MAN TEMP position. Wait _______ minutes for equilibrium to be reached.

5. Set the TEMPERATURE switch to _______ ^{o}C.

6. Turn the zero-measure switch to measure and adjust the ZERO AND STANDARDIZATION control until the meter reads the pH of the buffer solution.

   NOTE: This control has a backlash vernier. To use it, turn the control slightly beyond the correct setting and then turn it back for fine adjustment.

7. Turn the ZERO-MEASURE switch to ZERO. Record the meter reading for possible future use.

   NOTE: If the ZERO AND STANDARDIZATION control has been accidentally moved after it has been set, turn the ZERO-MEASURE switch to ZERO and adjust the ZERO AND STANDARDIZATION control until the meter reads the recorded value. Then turn the ZERO-MEASURE switch to measure and read the pH of the solution being measured.

8. Thoroughly wash the electrodes in distilled water and immerse them in solution to be measured. Wait _______ minutes for equilibrium to be reached.

9. Read the pH of the solution.

10. To avoid meter fluctuations when the electrodes are not immersed in solution, turn the ZERO-MEASURE switch to zero.

11. When not in use, the electrodes should be immersed in distilled water.

NOTE: Pointer position is adjusted by the screw in the middle of the pH meter cover. This is done with the power off. Before adjusting the pointer, allow several minutes for all circuit charges to drain off, or (with nothing connected to the thermohm terminals) turn the FUNCTION switch to AUTO TEMP position.

APPENDIX NO. 4

SFF Sampling Procedure

Important Note: No sampling is to be done without the permission and presence of supervision.

1. Connect the flexible line with ball joint connections to the sample bulb and to the sample line of the tank to be sampled.
2. Close the vent valve located between the sample bulb and the liquid trap.
3. Turn on vacuum.
4. Open the manual valve on the sample line of the tank to be sampled.
5. Pull the solution into the sample bulb (enough for the sample).
6. Close the manual valve on the sample line of the tank being sampled.
7. Turn off vacuum.
8. Open the vent valve.
9. Allow liquid to flow from the sample bulb to the sample bottle.
10. Cap the bottle and remove it from the cell when instructed by supervision. Follow "Sample Load-Out Procedure."
11. All excess solution is to be returned to its tank.

APPENDIX NO. 5

SFF Curium Precipitation Procedure

I. Chemical Make-Up

1. 1.5 liters of 1 M oxalic acid (189 grams of C.P. oxalic acid brought to a volume of 1.5 liters with distilled water).

2. 70% HNO_3 - At least one bottle at the make-up area and a small supply in a squeeze bottle in the cell.

3. Concentrated NH_4OH - Several bottles at the make-up area and a small supply in a squeeze bottle in the cell.

II. Operation

1. Check that all valves in Cell 1 are closed.

2. Check that the cask has been properly connected.

3. Check that the dipstick is in the "up" position. Check that the filter make-up is complete.

4. See supervisor for permission to transfer feed.

   NOTE: Supervisor must be present during transfer.

5. Turn on chilled water to tank T-11.

6. Turn on vacuum to T-11 (this automatically closes HOG to T-11).

7. Open the valve between the cask and T-11.

8. Transfer feed to T-11 until the bottom STT probe light comes on. Then turn vacuum off. (This automatically vents T-11 to HOG).

9. Close the block valve between the cask and T-11.

10. Sample T-11 according to SFF Sampling Procedure. Code No. ______ F1 and ______ F2. Request curium content and normality. Also request a gamma scan for fission products. Estimate ______ mc/ml Cm and ______ N HNO_3.

    NOTE: Supervisor must be present during sampling.

11. See supervisor at this point for permission to continue.

12. Turn on chilled water to P-11.

13. Turn on chilled water to C-11.

14. Open the block valve on the T-11 solution addition line.

15. Open the block valve between T-11 and P-11.

16. Transfer the solution from T-11 to P-11. When the liquid level in P-11 reaches ______% turn on P-11 agitator (set agitator at 90%).

17. When P-11 liquid level reaches _____% close the block valve between T-11 and P-11.

18. Close the block valve on the T-11 solution addition line.

19. Turn off chilled water to T-11.

20. Hold at this point until analysis has been received.

21. Heat P-11 to 50°C and digest at 50°C for 15 minutes.

22. Open the block valve on the P-11 solution addition lines.

23. Slowly add 1.5 liters of 1 M oxalic acid to P-11. Keep P-11 temperature at 50°C during this addition.

24. Add concentrated NH_4OH to P-11 to 100 ml increments until ______ ml have been added. Keep P-11 temperature at 50°C during the additions. Wait 3 minutes between additions.

25. Pull a sample from P-11 and determine the pH of the solution (see SFF pH Procedure); then return the sample to P-11.

26. If the pH is less than 2.0 add ______ ml conc. NH_4OH to P-11 and pull another sample. If pH is more than 3.0 add _____ ml of conc. HNO_3 to P-11 and pull another sample. Continue checking pH and adding HNO_3 or NH_4OH until pH is between 2.0 and 3.0. Hold at this point for 15 minutes (check pH constantly). Keep P-11 temperature at 50°C during this step.

27. Cool P-11 to 20°C.

28. Begin filtration as soon as possible.

APPENDIX NO. 6

SFF Safety Regulations

I. Protective Clothing and Equipment

1. Protective Clothing - The normal minimum protective clothing required for work at the SFF consists of the following: 1) safety glasses, 2) "Contamination" coveralls, 3) safety shoes. Such items as gloves, caps, jackets, etc., are provided for wear as needed.

   Coveralls should fit properly. Loose clothing can get snagged on equipment, too long coverall legs can lead to falls, or too tight coveralls can cause discomfort and loss of efficiency. Coveralls marked "Contamination" can not be worn outside of regulated zone areas except when traveling in a properly marked vehicle.

2. Gas Masks - Three types of gas masks in normal use at the SFF: 1) standard assault mask, 2) full-vision mask, and 3) air-supplied respirator. Gas masks are used in areas where air-borne contamination or vapor hazards exist or can be expected to occur. These areas are designated by supervision as they occur, and a gas mask must be worn. Certain areas are permanent gas mask areas. Gas masks are used once and then sent in for cleaning. They should be placed in the proper receptacles after use, not left lying around. Eye glasses can not be worn with either the assault mask or the full-vision mask.

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

3. Airline Suit - The airline suit is used at the SFF for protection from contamination and for some chemical work. It consists of three sections: 1) airline vest, 2) plastic top and helmet, and 3) plastic trousers. The vest is worn under the top and an airline connected to a snaptite fitting on the vest. A headband with airline attached fits around the forehead and two airlines extend into the legs of the suit. Compressed air at 25 psi is supplied to the suit. A drawstring in the top part of the suit allows it to be tightened just below the waist and air is exhausted at this point. Normally, not more than 50 feet of airline is used between the air supply and the suit; permission to use more must be obtained from building supervision.

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

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

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

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

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

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

5. Safety Glasses - It is a building regulation that safety glasses or their equivalent be worn at all times.

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

   1. Common sense suggests them and,
   2. Regulations require them.

   Failure to wear safety glasses is grounds for disciplinary action.

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

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

7. Safety Shoes - Safety shoes are supplied to all personnel and must be worn while working in the building.

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

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

   "Sash cord" is not to be used for safety lines.

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

II. Handling and Storing of Chemicals and Equipment

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

b) Loading areas will be chained off when lifting equipment or chemicals with the crane.

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

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

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

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

g) No solvents will be stored inside the building.

h) All areas shall be kept clean of materials at the safety showers, fire fighting equipment and exits.

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

III. Mechanical and Electrical Equipment

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

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

c) Danger tags will not be removed from equipment by anyone except the person who originally placed it on the equipment.

d) When not in use, the crane hook will always be left at least ten feet above the floor.

IV. Fire Fighting and Emergency Equipment

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

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

c) All personnel shall acquaint themselves with the operation and location of assault masks and airline suits.

APPENDIX NO. 7

SFF Inventory Sheet

Operator ______________ Shift ______________ Date ______________

Tank	Cell	Batch No.	Volume	Remarks
T-11	1			
P-11	1			
R-11	1			
S-11	1			
F-11	1			
V-16	6			
M-1	Make-up Area			
M-2	Make-up Area			

Signed ______________________
Shift Supervisor

SFF Shift Check Sheet

Operator ______________ Shift ______________ Date ______________

I. Off-Gas and Vacuum System

1. Filters

	PD HOG-S	PD HOG-P	PD SPARE-S	PD SPARE-P	PD VAC-S	PD VAC-P
Pressure Drop						

2. Check Vacuum Pump for Operation ______

II. Cell Ventilation System

Cell	1	2	3	4	5	6
Normal Cell Vent.						
Gage Reading						

Signed ______________________
Shift Supervisor

APPENDIX NO. 8

SFF Shift Supervisors Duties

The duties of the SFF Shift Supervisor will be (but not limited to) the following:

1. Log Book - An entry will be made for each shift. The entry should include process information, sample information, hazards discovered, unusual occurrences, and any other information that should be passed on to other shifts.

2. Shift Check and Tank Inventory - After the operator takes shift check or tank inventory, the SFF Shift Supervisor must sign the sheet. If, for any reason, these checks cannot be taken, this fact should be logged.

3. Samples - The SFF Shift Supervisor is responsible for logging all samples and sample results in the "SFF Sample Log". Samples are to be logged when they are pulled and request sheets made out at this time. If, for any reason, this cannot be done, this fact should be noted in the SFF Log Book.

4. Contamination Control - The SFF Shift Supervisor is responsible for seeing that all employees and visitors check themselves (or are checked) for contamination before leaving the building.

5. Building Check - The SFF Shift Supervisor shall take a tour of the building each shift looking for possible hazards, equipment needing repair, or improvements that could be made. Work orders are made out at this time and passed on to day shift.

6. Safety and Housekeeping - Safety is one of the primary responsibilities of the SFF Shift Supervisor. Since good housekeeping is conducive to safety, the SFF Shift Supervisor is responsible for seeing that the building is kept in an orderly fashion at all times.

7. General -
    a) The SFF Shift Supervisor shall be in the building at all times during operations.
    b) The SFF Shift Supervisor shall be at the cell window whenever liquid transfers or sampling is done.
    c) The SFF Shift Supervisor is responsible for seeing that all procedures are followed.

APPENDIX NO. 9

SFF Zoning Procedure

I. Regulated Zone

Definition: 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.

A. The SFF area is a regulated zone and signs to this effect are posted at all entrances to the area.

II. Contamination Zone

Definition: An area where control measures involve the contamination of employees, the environs, and/or equipment and where there is a possibility that radioactive material may become deposited inside the body leading to internal radiation exposure.

1. The SFF Area Contamination Zones:

   a) Manipulator Cells 1, 2, 3, 4, and 5
   b) Service Cell 6
   c) Cask facility and decontamination facility
   d) Sample and Waste Load-Out Station
   e) Other contamination zones may be designated on a temporary basis as needed.

III. Radiation Zone

Definition: An area where control measures involve external radiation exposure to personnel.

1. The SFF Area Radiation Zones:

   a) Manipulator Cells 1, 2, 3, 4, and 5
   b) Service Cell 6
   c) Cask facility and decontamination facility
   d) Sample and Waste Load-Out Station
   e) Roof of Building 3028
   f) Top of Cells 1, 2, 3, 4, and 5
   g) Other radiation zones may be designated on a temporary basis as needed.

IV. General Regulations

1. The bed of the one and one-half ton truck is a contamination zone. The cab of the truck is a regulated zone.

2. All personnel must be thoroughly checked before leaving the building. Victoreen meters, alpha survey meters, and hand and feet counters are available in the building for self monitoring. If in doubt, call Health Physics (Telephone 6263). If the required instrument or instruments are not available, regardless of reason, call Health Physics.

3. In areas where hand decontamination facilities are available, the hands must be decontaminated before leaving the work area.

4. If the clothing and/or shoes have any detectable contamination, change to clean clothing and put on shoe covers before leaving the work area. Request the necessary assistance to meet this requirement from your supervisor.

5. Contamination marked clothing may be worn anywhere in the SFF Area provided they are free from contamination.

6. Personnel working in contamination zones must be clothed in contamination marked coveralls.

7. Smoking and eating are prohibited in Contamination Zones.

8. Trainees, personnel on loan to the Laboratory, and visitors are subject to the provisions of these regulations in the same manner as Laboratory employees.

APPENDIX NO. 10

Radioisotope Area Emergency and Evacuation Procedure

Contents

1. Responsibilities of All Employees
2. Responsibilities of Person Discovering an Emergency
3. Responsibilities of Local Emergency Personnel
    - 3.1. Local Emergency Supervisor
    - 3.2. Local Emergency Squad
    - 3.3 Searchers
    - 3.4. Other Squad Members
4. Emergency Signals and Procedures
    - 4.1. Radioisotope Area Evacuation Signal
    - 4.2. Radioisotope Area Emergency Squad Signal
    - 4.3. Laboratory Evacuation Signal
5. Personnel Assignments
    - 5.1. Radioisotope Area Emergency Squad
    - 5.2. Radioisotope Area Searchers
6. Emergency Equipment
    - 6.1. Local Assembly Point
    - 6.2. Process Buildings
    - 6.3. Hazardous Areas
7. Evacuation Routes

1. RESPONSIBILITIES OF ALL EMPLOYEES

One of the most critical factors in combating emergencies is the ability of the person discovering an emergency to act immediately, with knowledge of what to do, where to get help, and how to get it fast. Any employee can become that person.

Be thoroughly familiar with:

The responsibilities of a person discovering an emergency (see Sec 2).

Location and use of fire-fighting and other emergency equipment in the immediate area.

Plans and assembly points for local and Laboratory-wide evacuations.

Local and Laboratory-wide alarms and signals (radiation monitoring, fire, evacuation, etc.).

Names of local emergency personnel in the immediate area.

In an emergency, follow directions of local emergency squad personnel and/or instructions over the public address system.

When instructed to evacuate by alarm or voice:

Shut down equipment if possible.

Leave the building or immediate area quickly.

Proceed to the local assembly point.

Stay there until otherwise instructed.

2. RESPONSIBILITIES OF PERSON DISCOVERING AN EMERGENCY

Take immediate and appropriate action to protect personnel, prevent property damage, and bring the emergency under control. This applies to fire, radiation, explosion, personal injury, or any other emergency, and can be accomplished by one or more of the following methods:

Control the emergency singlehanded if possible.

Telephone 6358 (Emergency Control Center) for help.

Pull the nearest fire alarm box.

Call the local emergency supervisor or warden on the Emergency Page System.

Call a local emergency squad member or anyone near.

If necessary, evacuate the area by an announcement on the Emergency Page System.

Meet and orient the emergency service unit or units.

When a call is received by the Emergency Control Center at 6358, the dispatcher immediately notifies the Laboratory Shift Supervisor and dispatches the emergency service units needed (Fire, Guard, Ambulance, Radiation Survey, electrician, chemical operator, etc.).

3. RESPONSIBILITIES OF LOCAL EMERGENCY PERSONNEL

A local emergency squad consists of a local emergency supervisor, wardens, searchers, and other squad members. The responsibilities of each are outlined below.

3.1. Local Emergency Supervisor

Organize and train the local emergency squad and plan for its use in handling the various types of anticipated emergencies; ensure that the local plans are consistent with the overall Laboratory plans. Maintain emergency equipment and evacuation plans.

In the event of a local emergency, direct his squad and ensure that:

Personnel have been evacuated from the affected area.

The Emergency Control Center has been notified.

Emergency service units are met, briefed on the situation, and directed to the scene.

Equipment and processes are shut down as necessary for safety.

The safety of the assembly point has been checked and moved if necessary.

The Laboratory Emergency Director is kept advised of the status of the emergency and of any needed assistance.

Additional manpower is secured if needed.

In the event of a Laboratory-wide emergency, comply with the instructions of the Laboratory Emergency Director, which may include:

Evacuating the area by an announcement of the Emergency Page System.

Accounting for all employees in his area after an evacuation.

Shutting down of process and building equipment.

Assembling his local emergency squad and dispatching it as directed.

3.2. Local Emergency Squad

Control or localize any emergency.

Direct employees from the emergency area to the local assembly point.

Prevent reentry.

Have employees monitored for radioactivity, if need is indicated, before dismissing them.

Direct employees to other assembly points as instructed over the public address system.

3.3. Searchers

Search all areas of building to make sure all employees have evacuated and report to the Local Emergency Supervisor.

Assist the Local Emergency Squad.

3.4. Other Squad Members

Notify or summon assistance from the proper emergency service unit

Meet and orient the emergency service unit when it arrives.

Make necessary operational changes.

Combat the emergency as required.

Provide rescue service and first aid if required.

4. EMERGENCY SIGNALS AND PROCEDURES

4.1. Radioisotope Area Evacuation Signal

The signal for evacuation of the area is a verbal announcement over the ORNL public address speakers located in the Radioisotope Area buildings and 3026-C building. Thirteen phones located at strategic points in the areas under the jurisdiction of the Isotopes Division are equipped with an emergency page button. The emergency page system is activated when the red button on the phone is manually held in the down position. A verbal announcement to evacuate the area is repeated three times.

When the evacuation announcement is received, the Radioisotope Area personnel will evacuate to the grass plot between Central Avenue and Building 3038. They will wait there for instruction from the "Local Emergency Supervisor" or the "Laboratory Emergency Director" who is the Laboratory Shift Supervisor on duty at the time.

4.2. Radioisotope Area Emergency Squad Signal

The signal for summoning the "Radioisotope Area Emergency Squad" is a verbal announcement over the Radioisotope Area emergency page system. Personnel requiring emergency assistance will activate the signal by holding down the red push button on the phone and verbally stating an emergency exists in a specific location. This announcement will be repeated three times, slowly and distinctly, to ensure that all emergency personnel have received the message.

The Emergency Squad, the local Emergency Supervisor, and Health Physics personnel will assemble at the announced location and take whatever action is required to handle the emergency.

4.3. Laboratory Evacuation Signal

The Laboratory evacuation signal is a siren-like wail over the ORNL public address system. All radioisotope personnel will follow evacuation routes and assemble in the grassed area south of Building 3038. Further instructions will be given on the public address system.

5. PERSONNEL ASSIGNMENTS

5.1. Radioisotope Area Emergency Squad

The following personnel are assigned to the Radioisotope Area Emergency Squad and will be trained by the Local Emergency Supervisor to handle emergency situations according to Secs 3.2 and 3.4.

Local Emergency Supervisor	R. W. Schaich
Alternate Emergency Supervisor	C. V. Ketron
Squad Members	E. H. Acree B. F. Early F. Huber R. D. Johnston J. A. Jones B. P. Phillips E. E. Pierce W. G. Tatum F. V. Williams

5.2. Radioisotope Area Searchers

The following personnel are assigned as "Searchers" for their respective buildings and will be trained by the Local Emergency Supervisor to handle the duties listed in Sec. 3.3.

Building	Searchers	Alternate
3037 - Second Floor	J. Ratledge	H. Austin
3037 - First Floor	P. B. Orr Anne Caylor	H. T. Russell Karyl Hall
3038 - Shipping and Cold Lab	W. Campbell	E. L. Biddle
3038 - Analytical Lab	H. Parker	J. Morton
3028E 3028W	R. Osborne	V. Johnson
3029	E. Maples	H. Harmon
3030 3031 3032	C. McFarland	S. T. Carroll

Building	Searchers	Alternate
3033 3034 3035	J. Smith	K. Campbell
3047	E. E. Pierce	R. Sizemore

6. EMERGENCY EQUIPMENT

6.1. Local Assembly Point

The Local Emergency Supervisor or a designated emergency squad member will inventory and maintain an emergency supply cabinet at the local assembly point (southwest corner 3038 building). This cabinet will contain gas masks, plastic boots, coveralls, airline suits with portable air supply, rubber and cotton gloves, emergency lanterns, rope, and any other item required for emergency problems.

6.2. Process Buildings

Individual building emergency cabinets will be supplied and maintained for quick access during a local emergency. They will contain three gas masks and one complete change of protective clothing.

6.3. Hazardous Areas

A system of permanent posts with cow chains attached will be maintained at strategic locations in the Radioisotope Area to facilitate the isolation of hazardous areas.

7. EVACUATION ROUTES

The evacuation routes are shown on appropriate signs which are posted in strategic locations in the area. All visitors will be evacuated in the same manner as regular personnel.

APPENDIX NO. 11

SFF Liquid Waste Handling Procedure

Cells 1 through 4

Cell liquid waste in Cells 1 through 4 will go to W-1 by way of the floor drains. During normal operations the drain in each cell will be covered. Hot process waste will be drained from R-11 to W-1 only with the permission of supervision. Waste will be pumped from W-1 to WC-1 only with permission of supervision. Proceed as follows:

1. Check WC-1 liquid level. Make sure that WC-1 can hold the volume that will be pumped to it. If WC-1 is too full (or if there is any doubt) call the tank farm supervisor (Phone 6234) and request that WC-1 be jetted before proceeding.

2. Sample W-1 if needed (check supervision).

3. Prime the waste pump as follows:

   a) Open the block valve located just below the funnel at the pump pit.

   b) Pour water into the funnel until the funnel begins to fill up.

   c) Open the block valve located in the pump pit and allow the water to begin flowing into the pit.

   d) As the water level in the funnel drops, add more water to the funnel. Continue water addition until about two liters have been added.

   e) When the two liters of water have been added, (and while there is still some water in the funnel) close the block valve located in the pump pit.

   f) Close the block valve located just below the funnel.

4. Open the valve to WC-1.

5. Start the pump.

6. Check W-1 liquid level. When W-1 liquid level reaches 0% turn off pump.

7. Close the valve to WC-1.

Cells 5 and 6

Cells 5 and 6 have floor and pan drains which go direct to WC-1. These drains are normally covered and are to be opened only with permission of supervision. The filter banks (HOG, VAC, and Stand-by) located in Cell 6 drain direct to WC-1. The vacuum surge tank, located in Cell 6, drains to W-1. This tank is to be drained only with permission of supervision.

APPENDIX NO. 12

SFF Off-Gas Filter Washdown

Whenever the pressure differential across the HOG Neva Clogs reaches 5.0 in., it will be necessary to wash the filters as follows:

1. Check that the drain valve on the "SPARE" bank of filters is closed.
2. Open the valve from the "SPARE" bank of filters to the stack.
3. Open the valve from process to the "SPARE" bank of filters.
4. Close the valve from process to the HOG filter bank.
5. Close the valve from the HOG filter bank to the stack.
6. Open the drain valve on the HOG filter bank.
7. Open the valve to HOG spray nozzles.
8. Wash the HOG Neva Clogs with water for 30 seconds.
9. Cut off the water and allow to drain for 15 minutes.
10. Close the valve to HOG spray nozzles.
11. Close the drain valve on the HOG filter bank.
12. Open the valve from HOG filter bank to the stack.
13. Open the valve from process to HOG filter bank.
14. Close the valve from the process to the "SPARE" bank of filters.
15. Close the valve from the "SPARE" bank of filters to the stack.
16. Check the pressure drop across the HOG Neva Clogs. If greater than 2.0 in., contact supervision about using chemical washes.

APPENDIX NO. 13

SFF

Vacuum and Off Gas CWS Filter Change

The CWS filters for the off-gas and vacuum systems are located in Cell 6. Upon instructions by supervision, the CWS filters will be changed as follows.

I. Off-Gas System

1. Wash down the HOG "mainstream" Neva Clogs as per "HOG Filter Washdown" procedure. Leave off-gas on the stand-by bank of filters.
2. Erect a plastic tent at the doorway of Cell 6.
3. Obtain Health Physics survey of Cell 6.
4. Enter Cell 6 under "Cell Entry Procedure."
5. Remove the HOG "mainstream" CWS filter and bag it out. Health Physics monitors filter removal and bagging.
6. Install the new CWS filter.
7. Remove the bagged filter from the cell.
8. Health Physics checks personnel and area for contamination.
9. Check with supervision concerning disposal of the old CWS filter.
10. Return the off-gas system to "mainstream" HOG filter bank.

II. Vacuum System

The procedure for replacing the CWS filter on the vacuum system is identical with the HOG system outlined above, except the vacuum system is switched to "Stand-by" bank of filters and the "Mainstream" Neva Clogs for the vacuum system are washed down.

APPENDIX NO. 14

SFF

Cell Ventilation Filter Change

I. Cells 1, 2, 3 and 4

Each cell has two filter banks. Each bank contains one cylindrical CWS filter covered by a stainless Neva Clog filter. One of the filter banks is designated as the "mainstream" bank and the other as the "stand-by" bank. Ventilation through these banks is controlled by manual gate valves and the mainstream bank is normally open while the stand-by bank is normally closed. On instruction from supervision, the mainstream CWS filter will be changed by the following procedure.

1. Insert a new CWS filter into the cell.
2. Open the gate valve on the "stand-by" filter bank.
3. Close the gate valve on the "mainstream" filter bank.
4. Adjust cell vent to normal operating valve.
5. Remove stainless steel Neva Clog filter.
6. Remove the CWS filter from the "mainstream" bank.
7. Install the new CWS filter in the "mainstream" bank.
8. Install the stainless steel Neva Clog in the "mainstream" bank.
9. Open the gate valve on the "mainstream" bank.
10. Close the gate valve on the "stand-by" bank.
11. Adjust cell ventilation if necessary to normal operating value.
12. Check with supervision about disposal of the old CWS filter. If it is to be removed from the cell, follow procedure for "Solid Waste Handling".

II. Cell 5

This cell has only one bank of filters. It will remain on stream while filters are being changed. It has a stainless steel Neva Clog filter over a CWS filter.

1. Insert a new CWS filter into the cell.

2. Remove the stainless steel Neva Clog filter.

3. Remove the old CWS filter.

4. Install the new CWS filter.

5. Install the stainless steel Neva Clog filter.

6. Adjust cell ventilation if necessary to normal operating value.

7. Check with supervision about disposal of the old CWS filter. If it is to be removed from the cell, follow procedure for "Solid Waste Handling".

III. Cell 6

This cell is equipped with one CWS filter. Since this is not a manipulator cell, a cell entry is necessary.

1. Prepare for cell entry as per "Cell Entry Procedure".

2. Health Physics enters cell and surveys.

3. Personnel enters and removes the CWS filter by hand. H.P. coverage is required during this operation.

4. Install the new CWS filter.

5. The old CWS filter is bagged up and removed from the cell.

6. Check with supervision about disposal of the old CWS filter.

7. H.P. checks the area for contamination and checks personnel.

IV. Neva Clog Filters

On instruction from supervision, the Neva Clog filters will be removed and washed down in the cell. After allowing the filters to dry, they will be installed over the CWS filters and cell ventilation will be adjusted to the normal operating value if necessary.

APPENDIX NO. 15

SFF Solid Waste Handling Procedure

All solid waste being removed from SFF cells will be handled in the following manner.

1. Set up the load-out station as follows:

   a) Cover the floor around the load-out station with blotter paper.

   b) Attach a new bag to the opening of the load-out station.

   c) Put the cask in position beneath the load-out station.

   d) Plastic suits will be worn by all personnel at the load-out station. Health Physics must be present during the load-out.

2. Insert a waste can, lines with a plastic bag, into the cell by way of the Cell 5 loading port.

3. Clean the waste as much as possible.

4. Place the waste in the lined waste can.

5. Close the plastic bag around the waste.

6. Fasten the lid to the can.

7. Move the can to the load-out dolly located between Cells 2 and 3.

8. Place the waste can on the dolly.

9. Check with supervision at this point.

10. Pull the dolly containing the loaded waste can into the load-out station.

11. Using the scraper, push the can from the dolly to the load-out port.

12. Allow the waste can to drop into the bag lined waste carrier.

13. Heat seal the plastic bag which now contains the waste can.

14. Using the "hot wire" cut the bag so that the can is sealed in the bag and the load-out port is also sealed in plastic.

15. Lower the waste carrier and replace the waste carrier lid.

16. Health Physics checks personnel for contamination and smears the area.

17. Health Physics smears the waste carrier and signs burial ground forms.

18. Waste carrier is taken to the burial ground.

19. When waste carrier is returned, it is checked for contamination by Health Physics. Clean if necessary.

APPENDIX NO. 16

SFF Chemical Make-Up Procedure

I. Protective Equipment

(a) All operating personnel will wear the following protective equipment during chemical make-up:

1. Face shields
2. Rubber gloves
3. Coveralls with sleeves fastened at the wrist
4. Safety shoes
5. Respirators while handling dry chemicals

II. Operating Procedure

(a) Premake-up checks:

1. Empty and flush make-up tank with water.
2. Add required quantity of water to the tank and cool to a temperature of 20°C.
3. Cooling water on the tank coils.
4. Mechanical agitator operating and giving the proper agitation to the solution.
5. Tank ventilation system is on and all other tank solid addition lids are closed. Check for a definite air sweep into the make-up tank being used.
6. Turn off water addition valve to prevent overflowing tank while adding chemicals.

(b) Make-up:

1. Add all dry chemicals with a scoop or shovel and hold tank temperature below 50°C.
2. Add acid solutions very carefully while holding tank temperature below 50°C. Acids may be added via Vanton pump, stainless steel bucket, or glass bottles.

(c) Chemical addition to process cell tanks:

1. No addition to cell tanks will be made without presence of supervision.

2. All chemical addition to process cell tanks will be followed by a water flush through the addition funnel. The quantity of water added will be determined by supervision.

APPENDIX NO. 17

SFF Vacuum Filter Washdown

The vacuum bank of Neva Clogs will be washed down in the same manner as the HOG bank of Neva Clogs with the following addition:

Check that vacuum pump is off before starting the procedure.

APPENDIX NO. 18

SFF Feed Cask Handling Procedure

1. Receive the cask at SFF. Health Physics takes radiation readings and smears.

2. Bring the cask to the cask unloading station.

3. Record pressure on the cask. The pressure gage is direct reading 0-1000 psi located outside the cupola.

4. Connect the cask to chilled water.

5. From this point on plastic suits will be worn and Health Physics coverage is required.

6. Remove the cupola lid and bag it. Check that the plastic covering over the cupola has not been torn.

7. Attach the plastic bag from the cask unloading station to the flange of the cask.

8. Working through the glove ports, remove the plastic covering from the cupola. Be careful not to rip the plastic between the cask flange and the unloading station.

9. Remove the "blank" from the HOG nozzle. (The HOG line is the one that the gage line branches from before it leaves the cupola to tie in with the 0-1000 psi gage).

10. Attach the HOG line in the glove box to the HOG nozzle on the cask.

11. Open the valve between the HOG nozzle and the HOG leg. This vents the cask to HOG.

12. <u>Close</u> the valve between the long leg (the center leg) and the solution entry leg (this is the "flush" leg).

13. Remove the "blank" from the long leg.

14. Attach the feed line in the glove box to the long leg of the cask.

15. Open the valve between the long leg and the feed line.

16. At this point cask hook-up is complete. Health Physics checks operating personnel and area for contamination. Transfer of material to Cell 1 can begin (check supervision).

Feed Transfer to Cell 1

1. Make sure that the block valve between T-11 and P-11 is closed.

2. Turn chilled water on T-11.

3. Obtain permission from supervisionto make transfer. NOTE: Supervision must be present during transfer.

4. Open the vacuum on Tank T-11. This automatically closes HOG to T-11.

5. Transfer ten liters of feed from the cask to T-11.

6. When ten liters have been collected in T-11, turn off the vacuum to T-11. This automatically vents T-11 to HOG.

7. Sample T-11 according to sampling procedure. Proceed with precipitation when instructed to do so by supervision.

8. Repeat Steps 1 through 7 until cask is empty.

9. When cask is empty, check with supervision.

Flushing

1. When the cask is empty it is to be flushed with five 2-liter distilled water rinses. Proceed as follows.

2. Under air line suit conditions, remove the "blank" from the nozzle of the "flush" line (this is the third nozzle in the cupola).

3. Attach the distilled water line to the flush nozzle. Open the valve between the flush nozzle and flush leg. Add two liters of distilled water to the cask.

4. Open the vacuum on T-11 and pull the two liter rinse from the cask to T-11.

5. Turn off vacuum to T-11.

6. Repeat Steps 3 through 5 four more times.

7. Sample T-11 according to sampling procedure. Supervision will determine if further flushing is necessary.

Disconnect and Decontamination

1. After flushing is complete, decontamination of the cupola will proceed. Air line suits will be worn.
2. Close the valve between the flush nozzle and the flush leg.
3. Disconnect the distilled water line from the flush nozzle.
4. Cap the flush nozzle with its blank.
5. Close the valve between the long leg and the feed line.
6. Disconnect the feed line from the nozzle of the long leg.
7. Cap the long leg nozzle with its blank.
8. Open the valve between the long leg and the flush leg.
9. With the cask still vented to HOG, decontaminate the cask to a level of 1000 d/m α. Use wipes and chemicals as directed by supervision.
10. When decontamination is complete, close the valve between the HOG leg and the HOG nozzle.
11. Disconnect the HOG line from the HOG nozzle.
12. Cap the HOG nozzle with its blank.
13. Seal the cupola of the cask with plastic.
14. Replace the lid on the cupola.
15. Disconnect chilled water to the cask.
16. Prepare cask for shipment.

APPENDIX NO. 19

SFF Chilled Water Procedure

I. Normal Operations

During normal operations the chilled water system is a closed system with process water being added to the 50 gallon surge tank automatically as it is needed. To operate the system, proceed as follows.

1. Open the valve marked "P.W. Header".
2. Open the valve marked "P.W. to Surge Tank".
3. Open the valve marked "Surge Tank to Pump No. 1".
4. Open the valve marked "Surge Tank to Pump No. 2".
5. Open the valve marked "No. 1 Pump to Chiller".
6. Open the valve marked "No. 2 Pump to Chiller".
7. Open the valve on the discharge side of the chiller marked "C.W. to Process Vessels".
8. Open the chilled water return valve marked "C.W. Return to Surge Tank".
9. Open the valve marked "P.W. to Condenser".
10. On the chilled water panelboard (located on the north wall near Cell 1 face), turn the No. 1 pump switch to the "ON" position.
11. Turn the No. 2 pump switch to the "Auto" position.
12. Turn on the chilled water compressor.

II. Emergency Operations

A. During a power failure the pumps will be off and chilled water will stop flowing. Proceed as follows.

   1. Close the valve marked "P.W. to Surge Tank".
   2. Open the valve marked "P.W. to Process Vessels".
   3. Close the valve marked "Surge Tank to Pump No. 1".

4. Close the valve marked "Surge Tank to Pump No. 2".

The above steps put the system on process water. The Surge Tank will overflow to the process drain. When power comes on proceed as follows.

1. Open the valve marked "Surge Tank to Pump No. 1".

2. Open the valve marked "Surge Tank to Pump No. 2".

3. Close the valve marked "P.W. to Process Vessels".

4. Open the valve marked "P.W. to Surge Tank".

Start pumps and compressor.

B. Contaminated Chilled Water

There always exists the possibility that the chilled water may become contaminated. If this happens proceed as follows.

1. Determine the tank where the leak occurred and valve off the chilled water to this tank. If it is impossible to determine which tank is leaking, valve off all chilled water to the tanks and pans and allow chilled water to return by way of the by-pass.

2. Open the valve marked "C.W. Return to Hot Drain".

3. Close the valve marked "C.W. Return to Surge Tank".

4. Turn off pumps No. 1 and No. 2.

5. Close the valve marked "P.W. to Surge Tank".

6. Close the valve marked "Surge Tank to Pump No. 1".

7. Close the valve marked "Surge Tank to Pump No. 2".

8. Close the valve marked "No. 1 Pump to Chiller".

9. Close the valve marked "No. 2 Pump to Chiller".

10. Open the valve marked "P.W. to Chiller" and allow process water to flush out the system.

NOTE: If the chilled water is contaminated to such an extent that working time near the unit is limited, proceed as follows.

1. Open the valve marked "C.W. Return to Hot Drain"
2. Close the valve marked "C.W. Return to Surge Tank"
3. Leave pumps No. 1 and No. 2 on

These steps will allow process water to enter the system at the surge tank and pass through once and be discharged to the hot drain (WC-1). Do Not allow the surge tank to overflow.

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