2. FACILITY DESCRIPTION

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2. NEW WASTE CALCINING FACILITY DESCRIPTION

2.1 Introduction

This chapter provides descriptions of the NWCF and its processes to support assumptions used in the hazard and accident analyses. These descriptions focus on all major facility features necessary to understand the hazard and accident analyses. The information contained in Chapter 2 is considered descriptive and is used to support the analysis in the following chapters. All information in Chapter 2, except for Section 2.2, is considered descriptive and, therefore, does not require DOE review and approval. The topics covered in this chapter include the following:

1. Overview of the facility, including its inputs and outputs, mission; and history.

2. Description of the facility structure.

3. Description of the facility process systems and constituent components.

4. Description of confinement systems.

5. Description of the facility safety support systems.

6. Description of the facility utilities.

7. Description of facility auxiliary systems and support facilities.

2.2 Requirements

The parts of the Code of Federal Regulations (CFR), the design codes, the DOE orders, and the standards listed below are applicable to the NWCF Facility design:

1. 10 CFR 835.[1]

2. 10 CFR 830.120.[2]

3. 29 CFR 1910.[3]

4. DOE Order 5400.5.[4]

5. DOE Order 5700.6C.[5]

6. DOE Order 6430.1A.[6]

7. Atomic Energy Commission Health and Safety Design Criteria Manual.[7]

8. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.[8]

9. American Concrete Institute Standard 318-71.[9]

10. American National Standards Institute (ANSI) Standard A58.1-1972.[10]

11. ANSI Standard B31.3-1975.[11]

12. ANSI Standard C2.[12]

13. ANSI Standard C5.1-1969.[13]

14. ANSI Standard C96.1-1964.[14]

15. ANSI Standard N101.6-1972.[15]

16. Energy Research and Development Administration (ERDA), ERDA Manual, Appendix 6301.[16]

17. Institute of Electrical and Electronic Engineers (IEEE), Standard 344-1975.[17]

18. International Conference of Building Officials, Uniform Building Code.[18]

19. NFPA 70.[19]

20. NFPA 30.[20]

21. Underwriters Laboratories, Electrical Construction Materials List.[21]

The majority of these requirements were part of the original design of the NWCF.

2.3 Facility Overview

The NWCF replaced the Waste Calcining Facility (WCF), which was the world's first plant-scale prototype waste calcining facility. The WCF began hot operations in 1963. The NWCF uses the same fluidized-bed calcination process, proved reliable in the WCF, to safely convert radioactive liquid waste into a granular solid called calcine. Improvements in (1) the materials of construction, (2) process systems, (3) operating methods, and (4) equipment design were incorporated into the NWCF by evaluating the latest technology and years of successful WCF operations and maintenance experience. Furthermore, remote techniques were developed and applied throughout the facility, especially in areas where radiation fields would be high and maintenance activities most probable.

The NWCF houses the calciner, the high-level liquid waste evaporator (HLLWE), the filter leach system, associated process equipment, an equipment decontamination area, and the H&V equipment. This facility was designed in accordance with applicable codes and DOE requirements at the time of design. The building has three main levels, one abovegrade and two belowgrade, and two main areas, the decontamination area and the calciner area.

Process control takes place abovegrade on the first level of the calciner area, while the calcination process and the evaporation of high-level liquid waste take place belowgrade on the second and third levels. Decontamination area activities are conducted abovegrade on the first level and belowgrade on the second level at the west end of the building.

The calciner, the HLLWE, associated process vessels, and equipment handling radioactive effluent are housed belowgrade on the second and third levels in steel reinforced concrete cells or cubicles to provide environmental and personnel protection (e.g., confinement and shielding of radioactive sources).

All process vessels, cells, and associated equipment are arranged in a configuration for ease of operation and maintenance. The majority of the cells are bordered by corridors to provide access and space for remote maintenance operations, instrumentation, other equipment, and utility runs.

The administrative and radiological control technician (RCT) offices, the lunchroom, locker and shower facilities are located abovegrade on the first level. A decontamination area and ventilation and exhaust systems are also located on this level. For personnel safety, self-monitoring stations are strategically located on this level, and passageways with airlock-type features are provided at all exits and stairways to help maintain contamination control. Hatches in the cubicles and the cells provide access for maintenance and for removing and replacing equipment.

The upper portion of the calciner area cells and valve cubicles, most instrument transmitters, and liquid and solid sample stations are located one story belowgrade on the second level. An operating and access corridor borders the cells and cubicles. Shielded viewing windows, tool ports, and cell and cubicle access airlock-type passageways open into the corridor. Master-slave manipulators for some cells and the flowmeter cubicle are operated from this corridor. The calciner area, at this level, also houses fluidizing and transport air blowers, continuous air monitor (CAM) blowers, and off-gas blowers. The decontamination area is isolated from the calciner area at this level by a double-door passageway (similar to an airlock) to limit the possible spread of contamination. Self-monitoring and personnel decontamination stations and double-door passageways are installed at the stairs for personnel protection and contamination control.

Access to the major process cells and the valve cubicle is gained from two stories belowgrade on the third level. An operating and access corridor borders the cell and valve cubicle area. Shielded viewing windows, tool ports, and labyrinth-type passageways penetrate the shielding walls without decreasing the required shielding characteristics. Master-slave manipulators for some cells are operated from the corridor. Self-monitoring stations, personnel decontamination areas, and double-door passageways are installed at the stairs for personnel protection and contamination control.

The hot sump tank cell (102) and a valve access room (101) are located below the third level and are accessible through ceiling hatches. The hot sump tank pump motor is designed to be semiremotely maintained and replaced through the hatch area, which minimizes radiation exposure to maintenance personnel. All liquid waste resulting from cell and vessel decontamination efforts drain to these tanks.

The spread of contamination is minimized by three major and other minor building ventilation systems that direct airflow from areas with lower potential for contamination to areas with higher potential. The decontamination area supply and exhaust system serves the portions of the decontamination area and the calciner area that are aboveground on the first level. The control room and computer room are served by their own independent system. The belowgrade processing areas are served by the calciner area system. These three major systems help prevent possible cross-contamination within the facility. Calciner area supply and exhaust air and the inlets to the process cell areas are filtered by high-efficiency particulate air (HEPA) filters to prevent contamination release or backflow in case of a mechanical failure or an accidental cell or cubicle overpressure.

The nominal processing capacity of the calciner is 3000 gal per day of net liquid waste. With this capacity, the calciner is able to process approximately 800,000 gal of waste per year. Some solutions are processed at lower rates to prevent exceeding NOx release limits.

Radioactive waste solutions that have been processed in the NWCF include the following:

1. Aluminum waste. Waste from the dissolution of aluminum-clad fuel in nitric acid followed by solvent extraction.

2. Zirconium-fluoride waste. Waste from the dissolution of zirconium-clad fuel in hydrofluoric acid followed by solvent extraction.

3. Sodium-bearing waste. Waste from concentrate from the process equipment waste (PEW) evaporator and decontamination solutions.

4. Coprocessing waste. A blend of zirconium-fluoride waste and aluminum nitrate waste.

5. Fluorinel waste. Waste from the dissolution of zirconium fuel in hydrofluoric and nitric acids followed by solvent extraction.

6. Rover waste. Waste from the solvent extraction of Rover fuel dissolver product.

7. Electrolytic (stainless steel) waste. Waste from the dissolution of Experimental Breeder Reactor II (EBR-II) stainless-steel-clad fuel in the INTEC electrolytic dissolver followed by solvent extraction.

8. Custom processing waste. Second- and third-cycle raffinate from the processing of custom fuel.

9. Liquid effluent treatment and disposal acid recycle waste. Low-level radioactive nitric acid (HNO_3) (< 13 M) from the acid fractionator bottoms in the liquid effluent treatment and disposal (LET&D) process.

With the phaseout of fuel reprocessing operations, only sodium-bearing liquid waste is presently being generated.

Table 2-1 depicts the typical waste composition that was expected to be generated from processing High Temperature Gas Reactor (HTGR) type fuel. Though HTGR fuel was never processed, it was used as a basis for the source term and design basis for NWCF shielding. The current Tank Farm waste is several orders of magnitude lower in radioactivity content than the waste listed in Table 2-1.

The existing calcine produced from the calcination of fuel reprocessing solutions had an average volume reduction factor of 8:1. The calcine generated from the calcination of sodium waste will have a volume reduction factor of approximately 2:1. The calcine is stored in the CSSFs, which are stainless steel bins contained in concrete vaults (partially buried underground) located near the NWCF.

Table 2-1. Estimated HTGR waste composition.

Ion	Concentration
H^+	1.9 M
NO^-	2.1 M
Al^{+3}	0.05 M
Cd^{+2} or B^{+3}	5 g/L
Na^+	0.02 M
HSO^{-3}	0.02 M
F^-	0.02 M
Fission products	12 g/L

Major Nuclides	Concentration (Ci/L)
^{3}H	0.18
^{85}Kr	7.42
^{89}Sr	1.89
^{90}Sr	41.76
^{90}Y	41.76
^{91}Y	3.39
^{95}Zr	5.51
^{106}Ru	9.30
^{106}Rh	9.30
^{123}Sn	0.23
^{125}Sb	1.77
^{127}Te	1.49
^{134}Cs	86.22
^{137}Cs	43.38
^{137m}Ba	40.54
^{144}Ce	96.89
^{144}Pr	96.89
^{147}Pm	16.22
^{151}Sm	0.11
^{154}Eu	2.27
^{155}Eu	1.55
^{233}Pa	0.39
^{241}Pu	1.27

The effluent streams from the NWCF include POG, H&V exhaust air, liquid waste, and granular calcine solids. The POG consists of calciner off-gas; vessel off-gas (VOG); and solids transport air, which is returned from the solids storage bins to the top of the calciner vessel. The calciner vessel POG passes through an extensive cleanup system consisting of a cyclone, a quench tower, a venturi scrubber, a knockout (KO) drum, a condenser, a mist eliminator, a heater, ruthenium adsorbers, a mist collector, a second heater, a HEPA-grade prefilter, double HEPA filters, and the atmospheric protection system (APS)[22] before being exhausted to the atmosphere through the INTEC Main Stack. The off-gases from vessels such as the blend and hold tanks and the HLLWE are combined with the calciner POG cleanup system just upstream of the mist collector. The inlet cell ventilation air for the process cells passes through filters. As this air exits the facility, it passes through a prefilter and two stages of HEPA filters and out the NWCF stack.

Liquid radioactive waste generated from the wet portions of the calciner POG cleanup system is recycled, and composes approximately 10 to 20% of the calciner feed stream. Decontamination solutions generated at the NWCF are generally evaporated and sent to the Tank Farm. Nonradioactive service waste (steam condensates and cooling water) is monitored for radioactivity before being discharged to the percolation ponds. If the radiological contamination in the service waste stream exceeds predetermined limits (see subsection 7.7.1.3), the stream is diverted to a waste storage tank, concentrated, and eventually calcined.

The transport air line from the NWCF to the CSSF is double-encased. The product is pneumatically transported to the stainless steel solids storage bins, which are enclosed in a concrete vault.

The NWCF has completed three campaigns since beginning hot operations in September of 1982. The third campaign was completed in November of 1993. A campaign at NWCF is approximately 12 to 18 months or until a predetermined volume of Tank Farm solution has been processed. The volume of waste processed during the first three campaigns is approximately 3,000,000 gal.

2.4 Facility Structure

2.4.1 NWCF Structural Description

The NWCF is a concrete and steel structure located northeast of the existing WCF. The NWCF is approximately 250 ft long and 145 ft wide, and extends 57 ft belowgrade and 43 ft abovegrade.[a] The facility is arranged so that process and decontamination areas containing large amounts of radioactive material and equipment are located belowgrade, while support areas containing little or no radioactivity, such as RCT offices, the control room, the maintenance area, and hands-on decontamination areas, are located above grade.

In general, the NWCF design is based on a modular (functional isolation) concept to help ensure the confinement of radioactivity. Process equipment is contained in cubicles or in process cells. Concrete shielding of appropriate thickness is used as the primary protection from penetrating radiation. Lead, iron, and other appropriate materials are used around cell penetrations where the concrete thickness is too thin to provide adequate shielding. The various forms of shielding used in the NWCF are adequate to protect plant personnel from radiation during normal operations and greatly reduces the radiation resulting from abnormal situations. The exposure rate at a distance of 1 ft from the cold face of a shield will not exceed 0.125 mR/h in areas where personnel could be located continuously for a 40-hour work

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a. Because of the very large number of dimensions specified in this chapter, metric conversions of English units are not given.

week (e.g., general working areas), and 1.25/t mR/h in limited-access areas (e.g., cell entryways), where "t" is the maximum average h/day occupancy ($1 < t < 8$). Penetrations through shielding for doors, hatches, windows, tool ports, piping, ventilation ducts, etc., are designed to provide the shielding required for area occupancy time. The NWCF shielding design is discussed in detail in Chapter 4 of this safety analysis.

Traffic flow and ventilation within the plant are designed to prevent the spread of contaminants from high- to low-concentration areas. RCT checkpoints are located to serve areas of high-contamination potential. The entire building is maintained under a slight vacuum to prevent any unfiltered leakage of contamination to the atmosphere. Compared with operating areas, radioactive areas are operated at lower pressure. The ventilation system is designed with an exhaust capacity that ensures an adequate flow through any opening to potentially contaminated areas. The ventilation system also permits an increase in airflow to any open cell or cubicle (e.g., during entry to a cell or cubicle for inspection, maintenance, etc.).

In general, equipment is designed to meet the design criteria with maximum consideration for reliability and simplicity of operation and maintenance. Airlifts, jets, etc., are used to move solutions to minimize the use of equipment with moving parts (e.g., pumps). Based on experience with the WCF, all equipment, piping, and instrument tubing were fabricated of materials capable of withstanding existing or anticipated process and decontamination solutions.

Process piping and valves in cells, not exposed to corrosive fluoride solutions but which could become contaminated as a result of an "upstream" failure, were fabricated of Type 304L stainless steel, which has shown satisfactory corrosion resistance in the WCF. Vessels and piping located in nonradioactive areas and not in corrosive service were fabricated of carbon steel.

The cell wall and floor linings were constructed of Type 304 stainless steel. The unlined areas of the cells are covered with three coats of chemical resistant epoxy paint on the floors and two coats on the walls.

With respect to fabrication, all NWCF process equipment was designed to meet the requirements of the ASME Boiler and Pressure Vessel Code. All vessels were fabricated from 3/8 in. to 7/8 in. thick rolled plate. Vessels are cylindrical (either vertically or horizontally mounted) with ASME-type dished pressure vessel heads of comparable thickness. Conical bottoms are used on those vessels where liquid drainage to a collection system is essential. All vessel welds were accomplished in accordance with accepted weld procedures and techniques. Postweld heat treatment was performed if required.

All associated piping was either seamless or welded. All fittings were forged from either seamless (preferred) or welded pipe. Pipe and fitting welds meet applicable ASME code requirements.

In accordance with applicable DOE requirements, the NWCF is designed to withstand the maximum credible conditions created by natural phenomena. This philosophy was implemented by "hardening" all of the belowgrade structures and those abovegrade areas necessary for process control and confinement against the consequences of area earthquakes and tornadoes. Other areas were constructed of structural steel and designed to support required loads, including those imposed by heavy-duty overhead cranes in the calciner maintenance area and the equipment decontamination room. Flood protection was incorporated into the design by building the grade level above the crest elevation for the maximum credible flood. A complete discussion of natural phenomena affecting the NWCF the associated design considerations is presented in Chapter 1 of this safety analysis.

2.4.2 NWCF Layout

The NWCF building has three main levels, one abovegrade and two belowgrade, and two main areas (the decontamination area and the calciner area). See Figures 2-1, 2-2, 2-3, 2-4, 2-5, and 2-6 for floor plans of the NWCF. Process control for the calciner area takes place on the first level while the calcination process takes place belowgrade on the second and third levels. decontamination area activities are conducted abovegrade on the first level and belowgrade on the second level at the west end of the building.

The following areas are located abovegrade on the first level:

1. RCT and shift supervisors' office (407)

2. Control room (438) and computer equipment room (439)

3. Switchgear room (433)

4. Decontamination solution makeup room (429)

5. Decontamination area (equipment decontamination room and low-level decontamination room) (418 and 415)

6. Calcium nitrate addition room (427)

7. Maintenance area (428)

8. Calciner supply air plenum room (601)

9. Standby generator room (432)

10. Personnel locker and change areas (404 and 406)

11. Operations offices (436 and 437)

12. Calciner exhaust air plenum room (423)

13. Decontamination supply air plenum room (503)

14. Decontamination exhaust air plenum room (426)

15. Vehicle entrance (417) and truck bay

16. Self-monitoring areas

17. Dry chemical storage (502)

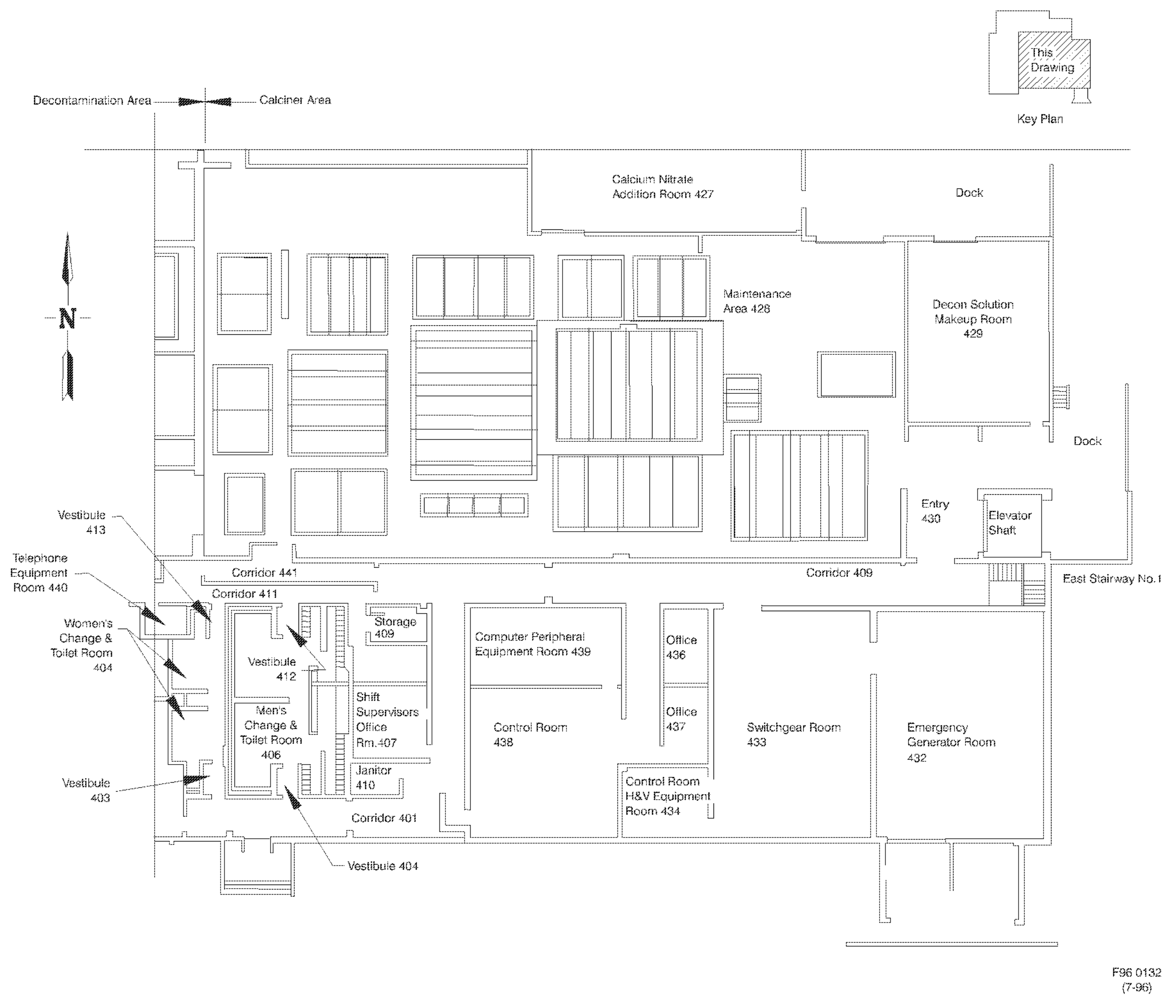


Figure 2-1. Partial floor plan, first-level calciner area.

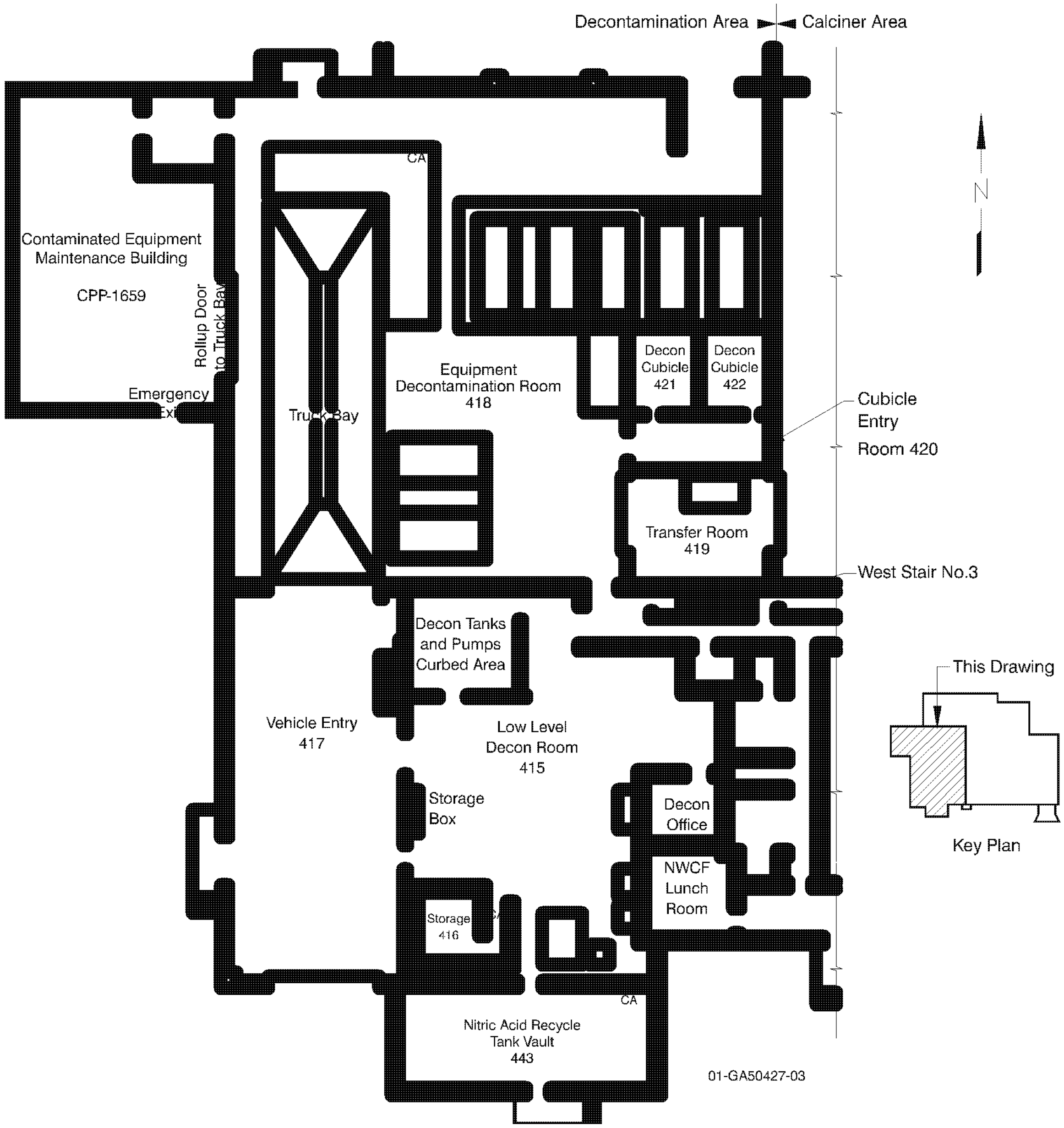


Figure 2-2. Partial floor plan, first-level decontamination area.

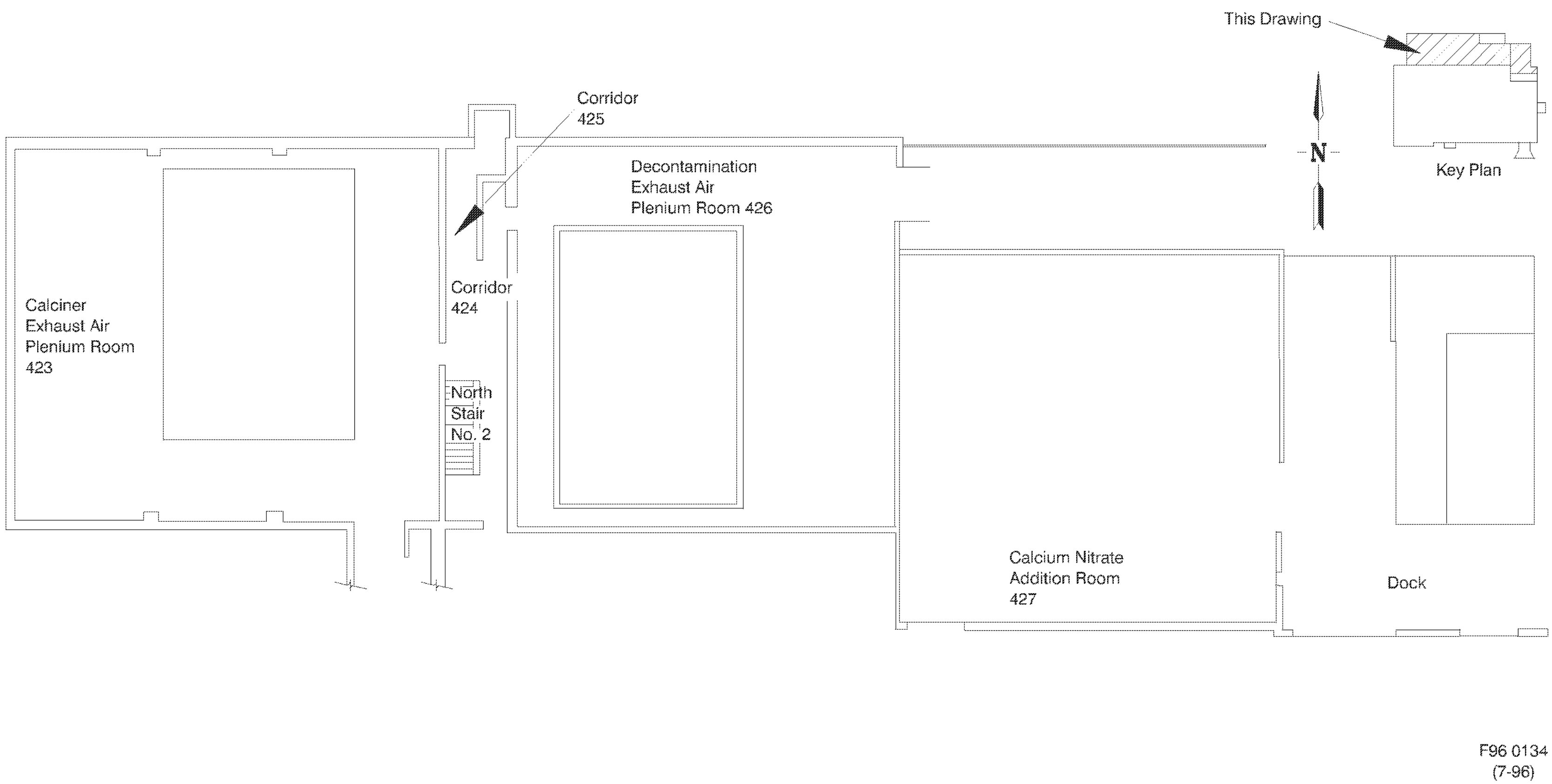


Figure 2-3. Partial floor plan, first-level air plenums and calcium nitrate area.

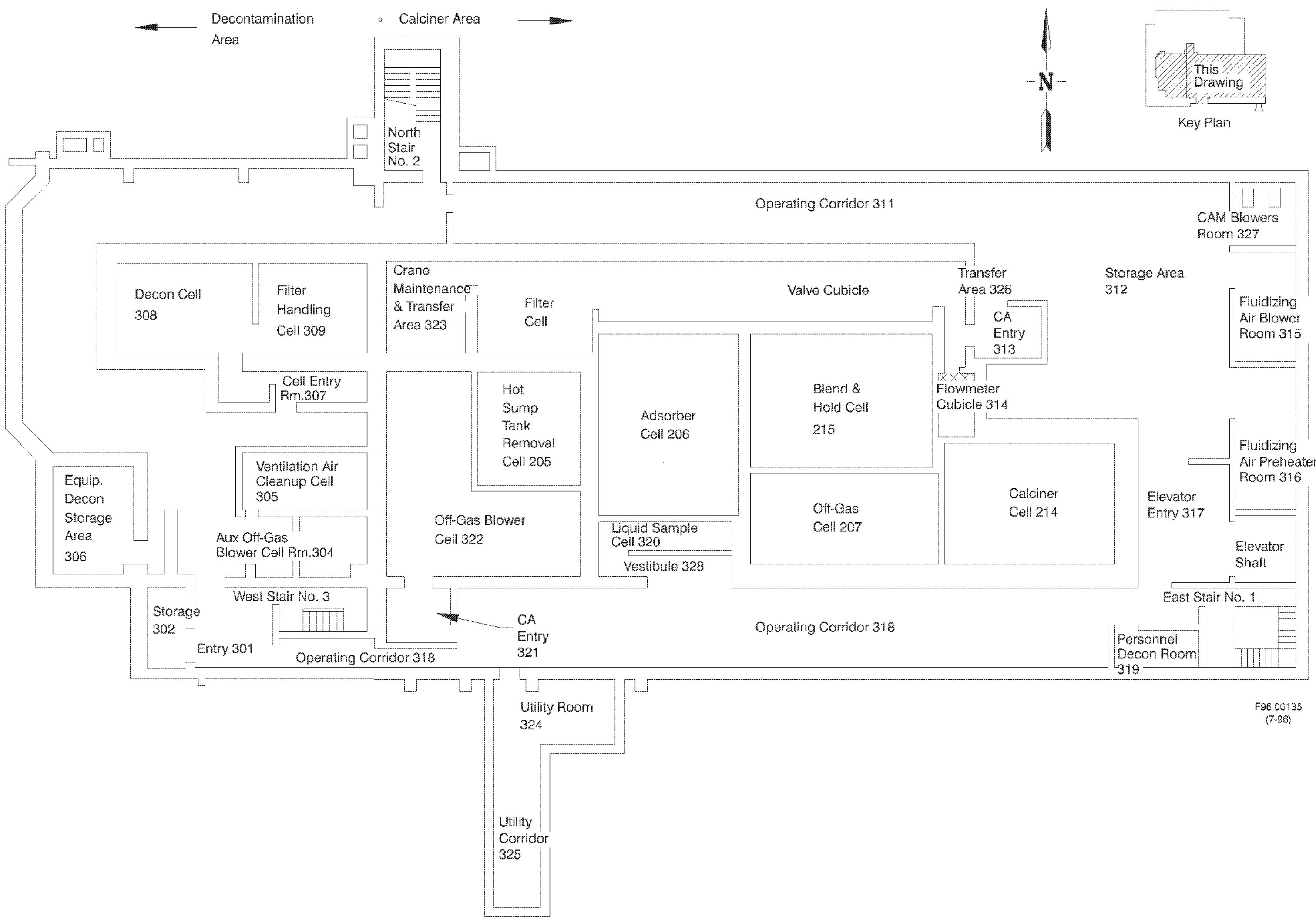


Figure 2-4. Second-level floor plan, calciner area and decontamination area.

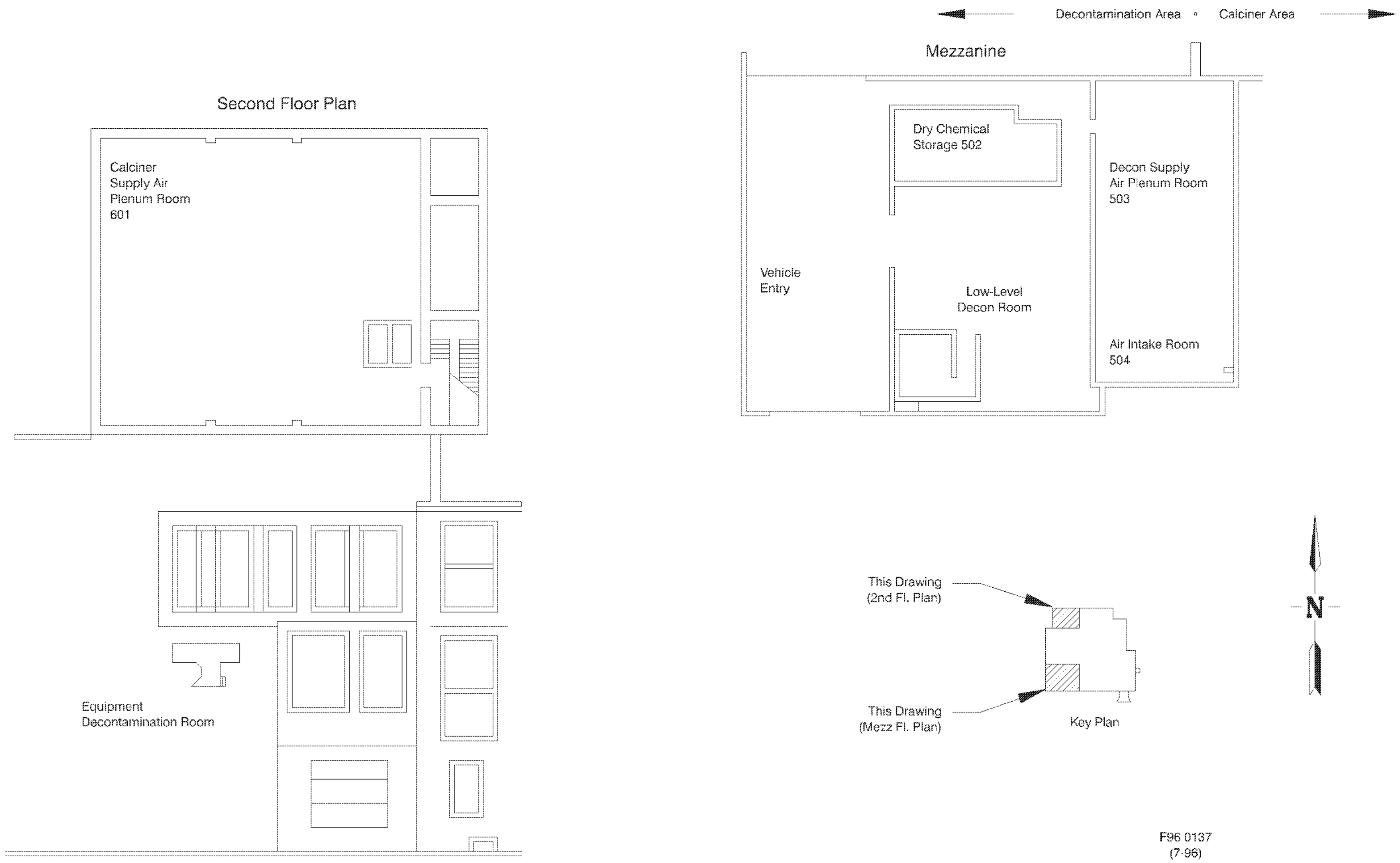


Figure 2-5. Floor plans for mezzanine and second level.

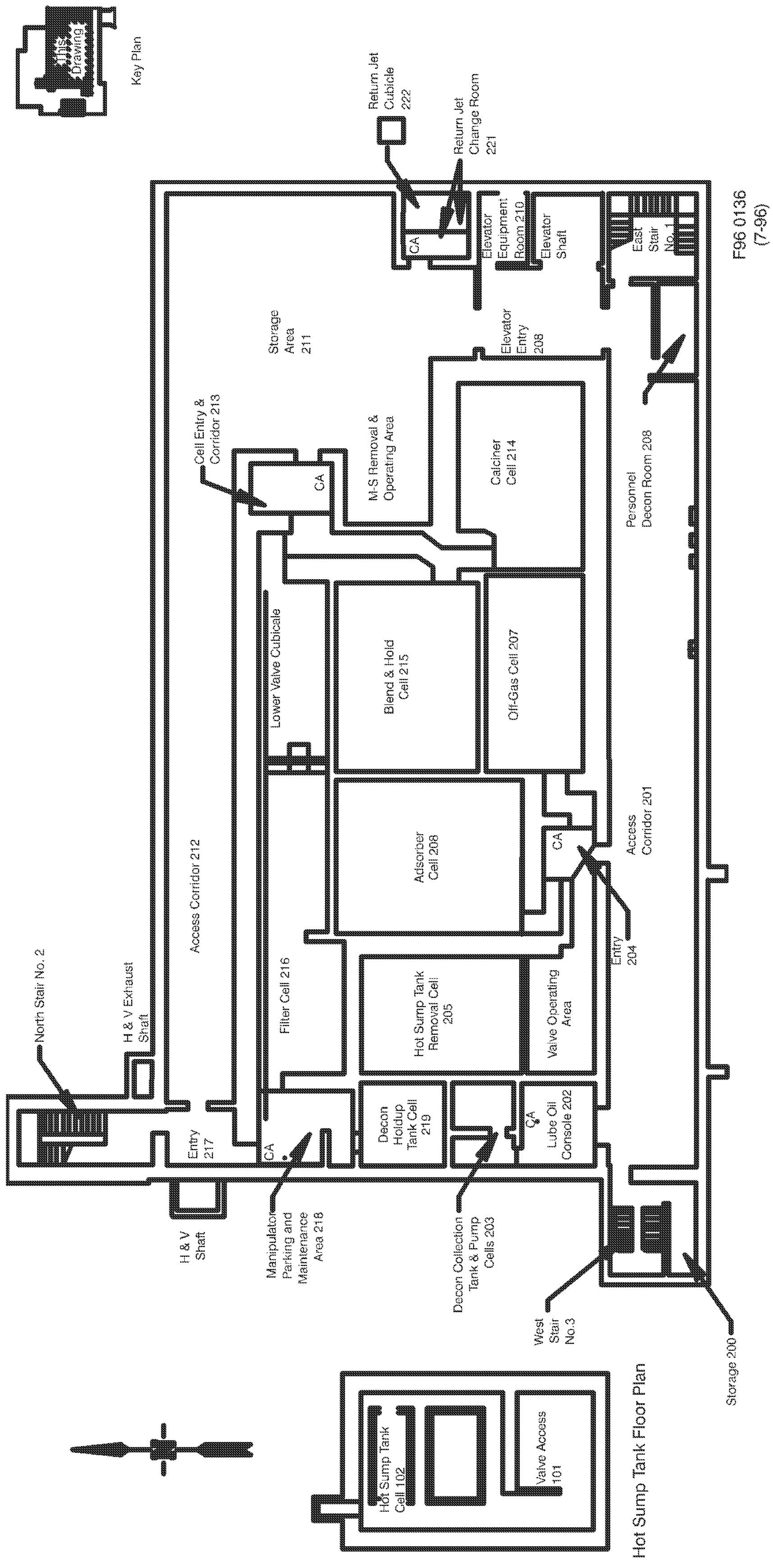


Figure 2-6. Third-level and hot sump tank cell floor plans, calciner area.

18. Telephone equipment room (440)

19. Control room H&V equipment room (434)

20. Decontamination cubicles (421 and 422)

21. Shielded storage (416)

22. Decontamination office (402) and transfer room (419)

23. Storage (408) and janitor (410)

24. Air intake room (504)

25. Calcine supply air plenum room (601)

26. Corridors (409, 401, 411, 441, 424, 435, 425, and 501)

27. Entries/vestibules (430, 431, 420, 412, 413, 405, and 403)

28. Nitric acid recycle tank vault (443).

Radioactive operations are conducted belowgrade on the second level. The following areas are located on the second level:

1. Fluidizing air blower room (315)

2. Off-gas blower cell (322)

3. Fluidizing air preheater room (316)

4. Upper valve cubicle (no number)

5. Filter handling cell (309)

6. Remote decontamination cell (308)

7. Auxiliary off-gas blower cell (304)

8. Ventilation air cleanup cell (305)

9. Liquid sampling cell (320)

10. Equipment decontamination storage area (306)

11. Flowmeter cubicle (solid sample cell) (314)

12. Personnel decontamination room (319)

13. Utility room (324)

14. CAM blower room (327)

15. Crane maintenance area (323)

16. Hot sump tank removal and access cell (upper level) (205)

17. Adsorber cell (upper level) (206)

18. Calciner cell (upper level) (214)

19. Off-gas cell (upper level) (207)

20. Blend and hold cell (upper level) (215)

21. Filter cell (upper level) (216)

22. Transfer area (326)

23. Utility corridor (325)

24. Entries and vestibules (328, 321, 310, 307, 301, 313, and 317)

25. Corridors (311, 303, and 318)

26. Storage areas (302 and 312).

The main access to the process cells in located belowgrade on the third level. The following areas are located on the third level, which is the lowest main level belowgrade:

1. Blend and hold cell (lower and access) (215)

2. Calciner cell (lower level and access) (214)

3. Off-gas cell (lower level and access) (207)

4. Adsorber cell (lower level and access) (206)

5. Decontamination collection tank cell (203)

6. Lube oil console room (202)

7. Decontamination holdup tank cell (219)

8. Hot sump tank removal and access cell (lower level and access) (205)

9. Filter cell (lower level and access) (216)

10. Valve cubicle (lower level and access) (no number)

11. Return jet cubicle change room (221)

12. Manipulator parking and maintenance area (218)

13. Personnel monitoring and a personnel decontamination area (208)

14. Return jet cubicle (222)

15. Entries (204, 209, and 217)

16. Corridors (201, 212, and 213)

17. Storage areas (211, 220, and 210).

The hot sump tank cell (102) and the valve access room (101) are the only areas located below the third level.

2.4.3 Description of NWCF Process Area

2.4.3.1 First Level. The first level, which was built at an elevation of 4917 ft above sea level, provides access to the administrative and RCT offices along with the rest rooms, locker and shower facilities, the calciner area control room, the first level of the decontamination area, the nitric acid recycle tank vault, and other support facilities. This level also houses the bridge crane, its loft area, the standby generator, and electrical switchgear rooms. Stairs and a freight elevator serve all levels. Ventilation equipment and plenum rooms for the NWCF are on this level. Self-monitoring stations are strategically located for personnel and environmental safety. Passageways (similar to airlocks) are located at most exits, stairways, and service openings to minimize the spread of contamination if accidental releases occur.

Shielding is provided between the first floor and the "hot" process cells below by concrete floors and hatches of sufficient thickness to reduce radiation levels to below DOE guidelines (0.125 mR/h at 1 ft from the cold surface) in accordance with the as low as reasonably achievable (ALARA) philosophy. In addition, shielding is provided between the decontamination area and all associated first-level facilities in accordance with the same guidelines and philosophies. A complete shielding discussion is given in Chapter 7 of this safety analysis. Exterior walls are structural steel and concrete with the walls of the control room, switchgear room, and standby generator room hardened to withstand the maximum credible effects of missiles generated by tornadic conditions. Partitions other than structural steel and concrete are constructed of cinder blocks or steel studs and have a semigloss latex enamel finish. The roof is built-up gravel on several layers of 1 in. rigid fiberglass insulation, tar paper, and tar.

2.4.3.1.1 Radiological Control Technician Office (407)—The RCT office provides work, equipment, instrumentation, and storage space for the following RCT activities to ensure personnel and atmospheric protection:

1. Personnel radiation and contamination surveys

2. Radiation area monitor (RAM) and CAM surveillance. (Annunciators and resets for the CAM and RAM systems are located in the RCT office. Rate meters for the RAMs and alarm panels for the CAMs are located in the control room. Alarms for the RAMs and CAMs can be reset only in the RCT office. The alarm annunciator in the control room can be silenced but not reset.)

3. Smear counting (area surveys, etc.)

4. Sample preparation equipment

5. Record keeping (exposure, smear surveys, etc.)

6. First-aid equipment

7. Communication system (telephone) to personnel decontamination rooms and other areas throughout the facility.

This area has approximately 480 ft^2 of floorspace with a 1 ft thick concrete floor covered by vinyl asbestos tile. The surrounding walls are metal frame covered with gypsum board. Major components are listed in Table 2-2.

Table 2-2. RCT office components.

Item	Description
1. Laboratory counter	A gas proportional alpha/beta/gamma detector with a lead shield placed on a table for counting smears and other samples. Methane gas is provided for the detector.
2. Computer terminal	A computer terminal tied into the radiation and environmental safety computer system.
3. First-aid	A first-aid cabinet containing adhesive bandages, disinfectant, ointment, swabs, etc., is provided for emergency first-aid treatment at the NWCF.
4. Instrument rack	Instrument rack to contain portable instruments.

The RCT office provides (1) an area capable of the functions described and (2) a central control point for monitoring direct radiation and contamination.

Ventilation air is supplied from the office area ventilation system. Approximately four air changes per hour are provided. Airflow patterns prevent contamination of the RCT office by potentially high contamination areas of the plant. An overhead wet-pipe sprinkler system is provided for fire protection.

2.4.3.1.2 Control Room (438) and Computer Equipment Room (439)—Control instrumentation necessary for efficient and safe operation of the NWCF is located on the first level in the control room (438). The NWCF distributed control system (DCS) is located in the control room. The DCS allows operating personnel to control the process and collect all pertinent operational data. Operational parameters and variables are monitored, adjusted, and controlled from this room to prevent radiation exposure to operating personnel.

This area has approximately 1230 ft^2 of floorspace with a 1 ft thick concrete subfloor and an elevated main floor to facilitate control and computer wiring and ventilation. All walls are 1 ft thick reinforced concrete for personnel and equipment protection (hardened for DBE and DBT). Major components are listed in Table 2-3.

Table 2-3. Control room and computer equipment room components.

Equipment Number	Name	Notes
DCS-NCC-901	Distributed control system (DCS)	Provides a central area for monitoring, recording, and controlling NWCF processes.
CP-NCM-982	Radiation area monitor (RAM) system	Panel houses power supplies, ratemeters, and annunciators for RAMs.
	Continuous air monitor (CAM) system	Only the annunciators for the CAMs are housed in the panel.
	Fire protection system panels	
HS-023-1	Rapid shutdown system (RSS) switch	Manual activation of RSS.
SULP-NCM-832	Uninterruptible power supply (UPS) circuit panel	UPS distribution (for the control room).
	Manual halon dumps (2)	Two switches for activating the Halon system. (The panel is equipped with a key-locked override manual system).
	Smoke detectors (each location has a pair, one ionizing, one photoelectric)	The detectors are located in three places: under the floor, on the false ceiling, and above the false ceiling. If two of the three detectors alarm with both pairs, the Halon system is activated.
WPCS-0B6-911	Waste processing computer system terminal	Provides plantwide data logging and data retrieval.
SIM-NCM-901	NWCF simulator	
EL-NCM-659-51	Egress lighting	
EL-NCM-659-44	Egress lighting	
EL-NCM-659-49	Egress lighting	
CP-NCM-981	DCS termination cabinet	

The control room provides (1) a centralized point from which the processes are controlled and monitored, (2) exclusion of any type of line (instrument, etc.) containing radioactivity from entering the control room, (3) a control point that is protected from severe natural phenomena (earthquakes, tornados, etc.), and (4) a control area that is protected from radiation hazards (i.e., direct and airborne contamination) and fire hazards.

The control room contains the primary indicating instrumentation; however, all primary sensing elements (transducers) and transmitters exposed to radioactive solutions are contained in or adjacent to the process cells on the second and third levels and are segregated from the control room. Secondary indicating instrumentation, which is usually a backup to the primary, is the local readout. This design philosophy simplifies the connections from process to transmitter to control room and prevents lines containing radioactive process solutions from entering the control room. Containment of these radioactive solutions at or near the point of origin is ensured by providing (1) an external block valve in each process sensing line for isolation purposes and (2) an external purge port in each process sensing line to clear line restrictions.

Radiation alarms are located in the control room panel (DCS-NCC-901), which is mounted on the south wall of the control room. This panel contains alarms for all of the NWCF RAMs and CAMs as well as the alarms for the effluent release streams, e.g., POG, ventilation air, steam condensate, etc. These alarms can be silenced from the control room but reset only by an RCT from the RCT office. The fire alarm signals are mounted in a panel located on the east wall of the control room.

Ventilation of the control room is provided by the control room H&V system located in Room 434. This system protects the control room from contamination by the use of filters and pressure differentials. Fire protection is provided by three pairs of smoke detectors, a halon system, and an overhead wet-pipe sprinkler system. Each pair of detectors consist of an ionizing and a photoelectric smoke detector. The locations of the detectors are under the raised floor, on the false ceiling, and above the false ceiling. If both the ionizing and photoelectric smoke detectors on any two of the three pairs of smoke detectors alarm, the Halon system is activated.

2.4.3.1.3 Switchgear Room (433)—The switchgear room provides a central location for most NWCF electrical switchgear and distributes selectively to the following groups of loads: (1) process, (2) environmental control, (3) material handling, and (4) instrumentation and computer.

This area has approximately 1400 ft^2 of floorspace with a 1 ft thick concrete floor and an epoxy deck. All walls are 1 ft thick concrete for personnel and equipment protection with an odorless gloss alkyd enamel finish. Major components are listed in Table 2-4.

The switchgear room functions include the following: (1) providing a room with the proper environment (temperature, humidity, etc.) to operate the switchgear, (2) providing an area that is hardened against natural phenomena (earthquake, etc.) to protect the NWCF from electrical disruption caused by damage to the switchgear, and (3) preventing the spread of contamination into the room from hot areas.

To accomplish the above contamination control, ventilation air is drawn from the outside through an adjustable louver and roughing filter. This inlet air is used to maintain the room at a higher pressure than the surrounding areas but lower than atmosphere before being exhausted through a shielded discharge vent.

2.4.3.1.4 NWCF Substation—The NWCF substation (substation number 30) contains two redundant 5-kV-rated feeders, each with a capacity of 1000 kVA and a maximum 2% voltage drop. This system distributes power to all building loads via the NWCF switchgear. The transformer is a pad-mounted outdoor type inside a wire mesh enclosure.

This area has approximately 200 ft^2 of mounting space, a 1 ft thick concrete and gravel pad, and a wire mesh enclosure. Major substation components are listed in Table 2-5.

The substation and the wire mesh enclosure functions include the following: (1) providing an electrical supply with the required characteristics (voltage, etc.) to NWCF switchgear; (2) preventing the intrusion of animals, windblown foreign material, etc., into substation equipment, which minimizes power disruptions; and (3) protecting personnel and equipment from accidental contact with the substation equipment.

Table 2-4. Switchgear room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
PCC-NCM-268	5 kV switch-board	---	---	2400 V, 1200 A 3-phase, 3-wire, 60 Hz, 50 MVA short-circuit interrupting capacity	Dead front with rear access, freestanding indoor type with the following components: Three electrically operated air circuit breakers (ACBs), 1200 A. One dummy breaker. Three spare cubicles for future electrically operated ACBs. Four fused controllers for transformer feeders. Two reduced-voltage, nonreversing, fused motor controllers. Metering and protective relaying.
STA-NCM-300A	Automatic battery charger	---	---	125 Vdc	Charger voltage input 208 Vac, 1-phase, 60 Hz.
STA-NCM-300B	Station battery	---	---	125 Vdc	60-cell station battery.
EPCC-NCM-304	Standby power control center	---	---	125 Vdc, 60 A	Main breaker 60 A, branch breakers: four-20 A, 2-phase.
XFR-NCM-123	Power transformer	---	---	300 kVA	2400-480 V, delta-delta windings, 3-phase, 60 Hz, dry type. Provides power to EPCC-NCO-275 (process electric heater control center).
XFR-NCM-124	Power transformer	---	---	750 kVA	2400-480/277 V, delta-wye windings 4.96% Z, 3-phase, 60 Hz, dry type. Provides power to the standby motor control center (EMCC-NCM-272).
XRF-NCM-125	Power transformer	---	---	750 kVA	Same as above except provides power to the standby motor control center (EMCC-NCM-273).
MCC-NCM-271	Motor control center	---	---	480/277 V, 1200 A, 3-phase, 4-wire, 60 Hz	42,000 A symmetrical bus bracing.
EMCC-NCM-272	Standby motor control center	---	---	Same as above	Same as above.
XFR-NCM-126	Power transformer	---	---	75 kVA	480-120/208 V, delta-wye windings, 3-phase, 60 Hz, dry type. Provides power to the standby power control center (EPCC-NCM-278).
EPCC-NCM-278	Standby power control center	---	---	120/208 V, 3-phase, 4-wire, 225 A	Main breaker: 225 A, 3-phase. Branch breakers: one-125 A, 3-phase; one-70 A, 3-phase; one-45 A, 3-phase; one-20 A, 3-phase; four-20 A, 1-phase.
REG-NCM-129	Voltage regulator	---	---	30 kVA, 120/208 V, 3-phase	Provides voltage regulation for a standby power control center (EPCC-NCM-277).
EPCC-NCM-277	Standby power control center	---	---	120/208 V, 3-phase, 4-wire 100 A	Main breaker; 100 A, 3-phase. Branch breakers: one-30 A, 1-phase; one-20 A, 1-phase; forty-15 A, 1-phase.
XRF-NCM-128	Power transformer	---	---	112-1/2 kVA	480-120/208 V, delta-wye windings, 3-phase, 60 Hz, dry type. Provides power the power control center (PCC-NCM-276).
XRF-NCM-128	Power transformer	---	---	112-1/2 kVA	480-120/208 V, delta-wye windings, 3-phase, 60 Hz, dry type. Provides power to the power control center (PCC-NCM-276).
PCC-NCM-276	Power control center	---	---	120/208 V, 3-phase, 4-wire 400 A	Main breaker: 400 A, 3-phase. Branch breakers: two-200 A, 3-phase; one-150 A, 3-phase; one-80 A, 3-phase; three-20 A, 3-phase; two-15 A, 3-phase.

Table 2-4. (continued).

Equipment Number	Name	Material	Dimensions	Capacity	Notes
CP-NCM-440-1	Control panel	---	---	---	Control panel for standby generator GEN-NCM-440-1
ELP-NCM-303	Standby lighting panel	---	---	277/480 V, 3-phase, 4-wire 225 A	Main breaker: 225 A, 3-phase. Branch breakers: eleven-20 A, 1-phase; thirteen-15 A, 1-phase.
LP-NCM-285	Lighting panel	---	---	120/208 V, 3-phase, 4-wire 225 A	Main breaker: 225 A, 3-phase. Branch breakers: eight-20 A, 1-phase; three-15 A, 3-phase; twenty-two-15 A, 1-phase.
LP-NCM-286	Lighting panel	---	---	Same as above	Main breaker: 225 A, 3-phase. Branch breakers: one-100 A, 3-phase; three-15 A, 3-phase; thirty-15 A, 1-phase.
LP-NCM-289	Lighting panel	---	---	277/480 V, 3-phase, 4-wire, 100 A	Main breaker: 100 A, 3-phase. Branch breakers: twelve-20 A, 1-phase; six-15A, 1-phase.
SUPS-NCM-830	Standby uninterruptible power supply	---	---	120/208 Vac, 3-phase 50 kVA	For DCS instrumentation.
BATT-NCM-830	Battery bank	---	---	120 Vdc, 240 A-h	For SUPS-NCM-830.

Table 2-5. NWCF substation components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
XFR-NCE-122	Transformer for motor control center	---	---	2400-480/277 V, 1000 kVA, 3-phase, 60 Hz	Delta-wye winding, pad-mounted, outdoor type, oil-insulated and self-cooled, rated for 5,000-ft altitude, 55°C rise.

The wire mesh enclosure is the main protective barrier against intrusion. Outside of animals and human beings, probably the next greatest hazard to the substation is lightning. Provisions are included that will prevent power surges in the transformer and NWCF electrical switchgear in the event of a lightning strike. The probability of lightning striking the substation is low because the NWCF building presents the highest point in the area of the substation and is protected with lightning rods. Furthermore, the INTEC Main Stack tends to draw all strikes in the INTEC area.

2.4.3.1.5 Decontamination Solution Makeup Room (429)—The decontamination makeup room provides an area for the receipt of chemicals from CPP-601, the makeup of chemical solutions at the facility and a distribution point for decontamination or scrub solutions for the NWCF.

The decontamination solution makeup room contains two decontamination solution makeup tanks and two centrifugal decontamination pumps. The cell and cubicle spray nozzles are served by insulated lines from this area. The tanks and pumps can be connected to any one of the lines desired by way of flexible hose connections. Low-level alarms on the tanks help prevent running the pumps without solution, which could damage the pump seals. Tanks are vented and air is exhausted outside through a mist eliminator. In addition, decontamination headers for equipment and service connections are run on the north and south sides of the NWCF.

This system allows internal and external remote decontamination of equipment and piping normally contacted by radioactive materials.

This area has approximately 1000 ft^2 of floorspace with a 1 ft thick concrete floor and a Type 304 stainless steel deck with a 6 in. wainscot. The east and north walls are structural steel because they are incorporated in the exterior structure of the building. The remaining walls are filled cinder block. Major components are listed in Table 2-6.

The decontamination solution makeup room functions include the following: (1) providing a centralized area for the makeup of decontamination solutions and (2) providing an area equipped for containment and easy cleanup of chemical vapors and spills.

The decontamination solution makeup room is protected from backflow of radioactive materials from the "hot" areas by check and block valves in all lines and by the elevated position of this cold area. Furthermore, vessels served by the decontamination system are operated at a negative pressure (vacuum) while the decontamination solution makeup tanks are operated at a slightly greater pressure to ensure the flow of materials from "cold" to "hot" areas. Plant water and steam are supplied through a parallel manifold header that joins into each of the main decontamination solution headers. Normally, the valves on these lines are closed, and the downstream side is blind-flanged to ensure that there is no backflow of radioactive solutions from the process during operations. The blinds are removed from the flanges to put the decontamination system back into service. Purge air is supplied to the spargers and the decontamination lines downstream of the blind flanges. These purge connections are provided with pressure regulators, rotameters, pressure gauges, check valves, and block valves to ensure against the backflow of radioactive solutions. All valves are closed and blind flanges are installed when the decontamination system is not in operation.

Both decontamination solution makeup tanks were leak-tested and spot-radiographed, and the steam (or water) coils were hydrostatically tested at 225 psig to ensure dependability.

Table 2-6. Decontamination solution makeup room components.

Equipment Number	Name	Material	Dimensions	Capacity	Note
VES-NCM-117	Decontamination solution tank	304L ss	5 ft dia x 8 ft 6 in. T-T, 5/16 in. wall thickness	1290 gal	Vertical, cylindrical tank fitted with internal heating-cooling coil (maximum heating duty of 1.5 million Btu/h), motorized agitator, level recorder alarm, and temperature indicator. Operating pressure of 0 psig and design temperature of 275°F. Vessel leak-tested and welds spot-radiographed. Heating-cooling coil hydrostatically tested at 225 psig. Tank mounted on support legs. Insulation 2 in. thick.
VES-NCM-118	Decontamination nitric acid tank	Same as above	Same as above	Same as above	Same as above.
P-NCM-217	Decontamination solutions pump	316 ss	---	100 gpm	10 hp, horizontal single suction, centrifugal-type pump with closed impeller, delivering 100 gpm at 50 psig. Fitted with pressure indicator and integrating flowmeter in discharge piping.
P-NCM-218	Decontamination nitric acid pump	Same as above	Same as above	Same as above	Same as above.

Hazardous chemicals are used for decontamination (HNO_3, permanganates, etc.) at the NWCF. Primary containment of these chemicals is provided by the decontamination solution makeup tanks and associated piping. In the event of a leak in a vessel or associated piping, controls (caution tags, safe work permits, etc.) and RCT requirements (respirators, acid clothing, etc.) help ensure personnel safety until the leak is repaired (pipe or vessel welded, valve replaced, etc.).

2.4.3.1.6 Decontamination Area—The decontamination area includes two stories abovegrade and one level belowgrade on the west end of the NWCF building. This area was designed to serve the NWCF and other INEEL areas.

The decontamination area serves to (1) reduce personnel radiation exposures; (2) preclude contaminant spread from work areas; (3) provide newer, more efficient and effective decontamination techniques; and (4) treat mixed hazardous waste for disposal.

The decontamination area is divided into two main rooms on the first level: (1) the low-level decontamination room (415) and (2) the equipment decontamination room (418), which contains two enclosed decontamination cubicles (421 and 422). In addition, there is a vehicle entrance (417) and truck bay, a steam enclosure, a mezzanine area for dry chemical storage (502), and the decontamination supply air plenum room (503).

2.4.3.1.6.1 Equipment Decontamination Room (418)—The equipment decontamination room is a 57 x 73 ft room located off the northwest corner of the maintenance area and north of the low-level decontamination room. The entire floor is 16 gauge Type 304 stainless steel. All walls not lined with stainless steel are covered with a protective epoxy coating. This room contains roof access to the remote decontamination cell (308), the filter handling cell (309), decontamination cubicles (421 and 422), and the equipment decontamination storage area (306). The operating corridor for the remote decontamination cell and filter handling cell is below this area on the second level. Decontamination solutions are transferred through stainless steel piping from the makeup area in the low-level decontamination room (415) to the supply outlets in the equipment decontamination room. Waste solutions drain to the decontamination area holdup or collection tanks.

The 30 ton bridge crane (CRN-NCD-901) spans and affords access to the entire equipment decontamination room. An auxiliary 5 ton hoist is also mounted on the crane trolley. Both cranes are remotely operable. Two crane control outlets are provided in the equipment decontamination room, and one shielded control station is provided behind a thick glass window mounted in the wall, dividing the room from the chemical mezzanine.

2.4.3.1.6.2 Decontamination Cubicles (421 and 422)—Items with sufficiently low radiation fields to allow contact or "hands-on" decontamination and disassembly, but with contaminant spread potential, are placed in the steam booth or one of the two decontamination cubicles (421 and 422). The roof of each cubicle consists of a single hatch (plug) that can be removed for crane access. The floors are concrete and lined with stainless steel. The walls are concrete finished with an epoxy coating. The cubicles are entered via a common passageway (420). Protective clothing change facilities and monitoring equipment are provided in the entry (420). Decontamination solutions, water, air, and steam are supplied to the cubicles. The wall thickness of the decontamination cubicles is one foot of ordinary concrete.

The floor of each cubicle slopes away from the door and walls to a drain in the north-west corner through which decontamination solutions are directed to either the decontamination collection tank (VES-NCD-129) or to the holdup tank (VES-NCD-123), and from there to the hot sump tanks. Ventilation air from the decontamination cubicles exhausts through the decontamination area plenum.

Stainless steel pipe stubs with quick-disconnect fittings (located inside the cubicles) and check valves (located outside the cubicles) are installed in the cubicle walls to provide decontamination solutions, water, and steam.

Currently a shielded waste loadout box filled with 6 kg of calcined solids, contained in stainless steel cans, is stored in the decontamination cubicle (422). The material is shielded by the waste loadout box and poses no radiation hazard external to the decontamination cubicle. The waste loadout box will have to be moved from the decontamination cubicle (422) to a more shielded area, such as the remote decontamination cell (308), prior to removing the individual canisters from the shielded waste loadout box, or removing calcined solids from the individual canisters. Calcined solids (contained solids stored in shielded casks or boxes) from future calcine sampling operations may be moved between areas such as the decontamination cubicles, the remote decontamination cell (308), or the filter handling cell (309), based upon storage space limitations. Such calcine movements would occur during calcine sampling operations to support normal operations or future disposition studies of calcine solids.

2.4.3.1.6.3 Vehicle Entrance (417) and Truck Bay—Entry to the truck bay from the vehicle entrance is gained through an 18 ft wide by 25 ft high rollup door. The truck bay floor and adjacent floor area near the remote decontamination cell are recessed 4 in. below the main floor and covered with stainless steel. At this same floor level, directly to the north of the truck bay, is a steam enclosure and decontamination spray booth with approximate dimensions of 18 by 30 by 15 ft high. The entire enclosure is lined with stainless steel. Water, and high pressure steam are supplied to the interior of the enclosure for hook-up to portable decontamination equipment. Breathing air is available in the area. The floor drain for the truck bay is in a trough that is covered with a removable grating. The truck bay is used for delivery of large contaminated items and pickup of decontaminated items. The truck bay floor and the area between the truck bay and the remote decontamination cell are designed to support 25-ton casks.

The vehicle entrance (417) is an area approximately 25 by 65 ft with its floor area recessed approximately 4 in. below the main decontamination area floor. The floor slopes to a central drain that discharges to the decontamination area holdup tank (VES-NCD-123). The floor is lined with stainless steel. The entryway is used for delivery and pickup of equipment, supplies, fuel casks, etc.

2.4.3.1.6.4 Low-level Decontamination Room (415)—The low-level decontamination room, which is approximately 48 by 63 ft, is located south of the equipment decontamination room. The entire floor is 16 gauge Type 304 stainless steel. Large items and chemical shipments are delivered through the 18 ft wide by 25 ft high rollup door from the vehicle entrance to the truck bay. The dry chemical storage mezzanine is above the solution makeup area. The low-level decontamination room (415) accepts small items requiring direct decontamination, such as tools and instruments. This room is designed to house the following equipment: an ultrasonic cleaner (UC-NCD-921), sinks with hoods (SH-NCD-933 and -934), decontamination solution makeup tanks (VES-NCD-127 and -128) and pumps (P-NCD-227 and -228), and a shielded storage box (CAB-NCD-930). The room also contains a shielded area (416). A dry chemical storage mezzanine (502) and the decontamination supply air plenum room (503) are located above the low-level decontamination room.

A large ultrasonic cleaner (UC-NCD-92) is installed in the low-level decontamination room complete with a heavy-duty stainless steel tank, and transducers and a power supply, which are of adequate size and power rating to induce vigorous cavitation in the liquids in the tank when full. The power input to the transducers can be variable to allow adjustment to maximum cleaning efficiency under a variety of uses. Waste from this tank drains to the decontamination area holdup tank (VES-NCD-123).

Electrical outlets (440 V, three-phase) and water taps are provided in the low-level and equipment decontamination rooms so that the pump can be used for high-pressure spraying in the remote decontamination cell.

The two laboratory sink hoods (SH-NCD-933 and -934) are provided for contact decontamination involving small to moderate-sized items. Both hoods contain heavy-duty stainless steel sinks, one hood accommodating a 10 ft long, 24 in. wide, and 18 in. deep sink; the other hood houses a smaller 20 in. long, 18 in. wide, and 18 in. deep sink. Both hoods are constructed of stainless steel, have vertically opening safety glass windows, and have storage cabinets under the sinks. Each hood is supplied with water, decontamination solutions, steam, compressed air, and electrical outlets. The sinks drain to the decontamination holdup tank. Linear airflow velocities through the hood openings are > 125 fpm + 25 fpm on average. The hood's air is passed through the vent air scrubbing system to remove acidic fumes before exhausting into the calciner area exhaust system.

2.4.3.1.6.5 Solution Makeup Area—The solution makeup area, with two solution makeup tanks (VES-NCD-127 and -128), is located at the northwest corner of the low-level decontamination room (415). The two 500 gal vertically mounted cylindrical, stainless steel solution makeup tanks are equipped with hinged lids; mixers; 2 in. diameter off-gas vent lines; internal steam coil heaters; sparge lines supplied with air or steam; and liquid level, density, and temperature probes. A stainless steel dry chemical chute extends upward from each tank to the overhead dry chemical storage mezzanine for charging chemicals into either tank. One of two centrifugal pumps (P-NCD-227 or -228) with a capacity of 30 gpm at 100 psig is connected to the outlet of each tank for delivery of solutions to the decontamination work stations. Locally mounted alarms for high and low liquid levels and a low-low liquid level signal are provided to cut the power to the pump and thereby prevent overheating and damage to the pump seals. The tanks are located in curb areas with gutter drains leading to the holdup tank (VES-NCD-123). Transfer lines lead from the two decontamination solution pumps to the remote decontamination cell, the filter handling cell, decontamination cubicles, sink hoods, and the ultrasonic cleaner. All wetted parts of the solution makeup and transfer system are constructed of Type 300-series stainless steel. Major components of the system are listed in Table 2-7.

The decontamination area provides (1) an area to contain and prevent the spread of radioactivity removed during decontamination work, (2) an area solely devoted to decontamination work that is equipped with the tools and materials that would make the area operate most effectively, and (3) sufficient shielding to maintain exposure rates at 1 ft from the cold side of shields at or less than 0.125 mR/h.

2.4.3.1.7 Calcium Nitrate Addition Room (427)—During the calcination of waste that contains fluoride, calcium nitrate ($Ca(NO_3)_2$) is added to the waste feed to complex the fluoride by forming calcium fluorozirconate, which reacts to form calcium fluoride and minimizes fluoride volatilization. Liquid and solid calcium nitrate and boric acid are received and stored in the calcium nitrate addition room. The equipment and instruments that receive, make up, store, and add calcium nitrate or boric acid are housed the room. The equipment in the room is operated from two control panels (CP-NCM-984 and -997). A truck unloading station for the liquid calcium nitrate is located at the CPP-659 east loading dock.

Table 2-7. Decontamination area components.

Room or Equipment Number	Name	Material	Dimensions	Capacity	Notes
Rooms 421 and 422	Decontamination cubicles	Concrete with ss floor	12.5 x 16 x 12 ft high	---	Air lock-type entryway.
CRN-NCD-901	Bridge crane, decontamination area	Carbon steel	69 x 15 x 7 ft	30 tons vertical	Control via crane control stations. Maintenance platform. Crane has 69 ft span, 37 ft reach, 81 ft 5 in. horizontal travel, and plumb lift.
SH-NCD-933, -934	Sink hoods	304L ss	10 x 2 x 1.5 ft sink 20 x 18 x 12 in. sink	225 gal and 18 gal	Hoods have vertically opening safety glass windows and storage cabinets under the sinks.
CAB-NCD-920	Maintenance hood	304L ss	4 x 4 x 10 ft	Linear airflow 125 fpm	
UC-NCD-921	Ultrasonic cleaner	ss	2 x 2 x 2 ft tank	60 gal	Heavy-duty ss tank, 10 kW transducers, variable power supply, tank heater, ventilation exhaust hood, and sound-adsorbing enclosure.
VES-NCD-127, -128	Decontamination solution makeup tanks	304L ss	4 ft in dia x 5.5 ft long with 3/8 in. wall thickness	530 gal	Vertical, cylindrical with hinged lids, top-mounted agitators, off-gas vent lines, internal steam coil heaters, and temperature sensors. Operating pressure - 0 psig; design temperature 275°F; sparge ring; 0.135 in. corrosion allowance. Raised manhole on top for connecting ss chute. Equipped with drain. Tanks mounted on support legs.
CAB-NCD-930	Shielded storage box with hoist	Lead and 304L ss, carbon steel for housing	2 x 4 x 2 ft high (internal dimensions)	16 ft^3	2 in. thick lead-shielded box with hinged lid and chain hoist for opening lid, off-gas vent line, roughing filter; all items stored sealed in plastic.
AG-NCD-427, -428	Decontamination tank agitators	304L ss for all wetted parts	76 in. x 1 ft x 1 ft	---	Motorized tank agitator mounted on flange on top of vessels (VES-NCD-127 and -128); ¾ hp.
LGW-NCD-904	Shielded window, decontamination area	High-density glass	18 x 24 in.	---	18 in. thick glass window between the equipment decontamination room and the chemical mezzanine.
HST-NCD-917	Hoist and monorail system	Structural steel	---	3 tons	Underhung multiple-path monorail hoist. Total hoist lift: 18 ft 6 in.; total track length: 148 ft; hoist carrier drive speed: 32 fpm; hoist speeds: 22 fpm and 7 fpm.

Table 2-7. (continued).

Room or Equipment Number	Name	Material	Dimensions	Capacity	Notes
---	Roof hatches on remote decontamination cell and filter handling cell	Concrete	18 ft long, width varies	---	Removable cell hatches.
FUN-NCD-927, -928	Dry chemical chute	ss	---	---	Funnel for dry chemical addition to the decontamination solution tanks. With fume hood, bottom valve, and pipe chute; mounted in decontamination area mezzanine. Pipe chutes connected to solution tanks below on the first level.
---	Roof hatch on each decontamination cubicle	Concrete	18 ft long, width varies	---	Removable cubicle hatches.
UC-NCD-921-B	Pump control panel	Epoxy-coated to NEMA[c] 4X standard	25 x 36 x 72 in.	---	Upright, freestanding medium-density control panel, fully wired and piped. Panel contains both electronic and pneumatic instruments required for decontamination area and to be N_2-purged for corrosion resistance.
SCL-NCD-936-1	Chemical scales	Carbon steel	---	---	250 kg platform type, wheel-mounted with large dial readout.
BLO-NCD-289	Laboratory hood exhaust fan (decontamination area)	All steel	15 in. minimum wheel diameter	2,400 scfm at 1-1/2 in. actual setpoint	Fans are centrifugal type, statically and dynamically balanced with AMCA[a] label; 1,800 rpm, 460 V, 3-phase, 60 Hz TEFC[b] motor. V-belt drive-sized for 200% motor nameplate horsepower with 2 belts and adjustable pitch motor sheave; belt guard; spring isolation rails.
P-NCD-227, -228	Decontamination solution pumps	316 ss for impeller and all wetted surfaces	---	30 gpm at 100 psig	Horizontal, single-suction, centrifugal type.
MCC-NCD-274	Motor control center	Carbon steel	20 x 20 x 90 in. modules	---	Motor control center, 480 V, 3-phase, 4-wire, 600 A main bus, freestanding, dead-front NEMA[c] Class II, Type B, vertical sections, externally operable control devices, 480/120 V control power transformer for each starter, control circuitry in separate compartments, 25,000 A short-circuit bracing.
LP-NCD-286	Lighting and distribution panelboards	Carbon steel	Approx. 30 x 10 x 48 in.	208/120 V, 3-phase	4-wire, dead-front, molded-case circuit breakers, 10,000 A symmetrical rms interrupting rating ground bus; NEMA PB-1 enclosure; surface-mounted 100 A main bus; 100 A 3-pole main breaker with 20 1-pole branch breakers, each with 20-A.

Table 2-7. (continued).

Room or Equipment Number	Name	Material	Dimensions	Capacity	Notes
LP-NCD-292	Lighting and distribution panelboards	Carbon steel	Approx. 30 x 10 x 48 in.	480/277 V, 3-phase	4-wire, dead-front molded-case circuit breaker, 14,000 A systemic rms interrupting rating ground bus; NEMA PB-1 enclosure; surface-mounted, 60 A main bus with 12 1-pole branch breakers, each with 20-A; no main breaker.
CP-NCD-989	Low-level decontamination room/pump control panel	Carbon steel	20 x 20 x 90 in. modules	---	

a. AMCA - Air Moving and Conditioning Association.
b. TEFC - Totally enclosed fan-cooled.
c. NEMA - National Electrical Manufactures Association.

The room has approximately 2860 ft^2 of floorspace and a 1 ft thick concrete floor with an epoxy deck. The east wall is structural steel because the wall is incorporated in the exterior structure of the building. The remaining walls consist of filled cinder block with an epoxy coating.

The truck unloading station located at the CPP-659 east loading dock is operated locally. The rest of the calcium nitrate addition system can be controlled locally or by the DCS. Major components are listed in Table 2-8.

High humidity is not desirable in the room. Ventilation air is supplied by inleakage from the outside and exhausted by its own exhaust blower. Local room heaters supply enough heat to maintain humidity levels in the room, which are compatible with calcium nitrate storage.

Protection from backflow of radioactive materials from a process area is provided by (1) manual block valves in all lines out of the calcium nitrate tank, (2) manual and automatic block valves in the lines for solid calcium nitrate addition, which are activated by the negative pressure in the hold tanks, and (3) by the elevated position of this "cold" area. Procedural controls require all block valves to be closed and blind flanges to be installed upon completion of a solid calcium nitrate addition to ensure backflow protection. If the flange and valves should leak, the flow is inward because the waste hold tanks are operated under a negative pressure (8 to 10 in. of W.C. vacuum), while the addition hopper and solution tanks are at atmospheric pressure to ensure that the flow of material is from a "cold" to a "hot" area.

The calcium nitrate addition tank was leak-tested and radiographed to ensure its dependability.

The contents of the liquid storage tanks (VES-NCM-134 and -135) will be contained inside CPP-659 in the unlikely event of a tank rupture. The vessels are installed inside an area with a low curb that contains any minor spills. The containment area also has a sump with leak detection capability. The containment area and curb are painted with a protective coating. The floor is sloped from the exterior walls to the floor drain in the room. The room serves as a secondary containment in the event of a single tank rupture. The room has the capability to contain 20 minutes of firewater. The pumps, valves, heater agitator, and filling meter are designed to be controlled from the DCS control panel located in Room 438. In addition to the DCS control, a local meter and alarm panel for the liquid calcium nitrate truck unloading station is located at the CPP-659 east loading dock. A local control panel is provided for the two liquid storage vessels. Each tank is equipped with a density and a temperature instrument and a high-level alarm. Density-, temperature-, and high-level alarm indication for each storage vessel is provided on the local control panel. The sump is equipped with a level alarm for leak detection. Lighting is also provided at the unloading station to ensure safety during nighttime unloading.

A supply of 100 psi air is located on the south wall of room 427 to pressurize the tanker truck during unloading of liquid calcium nitrate. A regulator and pressure gauge reduce the pressure to 35 psig when the tanker is unloaded. The piping and valving are designed to allow the solution to be pumped to either storage tank.

2.4.3.1.8 Maintenance Area (428)—The maintenance area provides working space for maintenance activities to be performed through the cell hatches and space for removal and storage of cell hatch covers. A bridge crane (CRN-NCM-901) facilitates cell hatch removal and equipment removal and replacement. An overhead PaR manipulator (CRN-NCM-902) is provided to assist with remote maintenance when the need arises.

The maintenance area is served by a bridge crane equipped with a 30 ton hoist and a 5 ton auxiliary hoist for the removal and replacement of the process cell hatch and equipment. This crane also serves the off-gas, fluidizing air, a CAM, and transport air blowers if removal becomes necessary. A PaR manipulator is located on a separate bridge.

Table 2-8. Calcium nitrate addition room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCM-120	Calcium nitrate solution tank	304L ss	4 ft in dia x 7 ft 4 in. T-T, 3/8 in. thick with 3 ft skirt	700 gal	Vertical cylindrical tank. Steam-jacketed (designed for 35-psig steam), ¾ hp motorized agitator on top flange (Mix Mor Model FG-34 or equal). Operating pressure of 0 psig; design temperature of 135°C.
AG-NCM-420	Tank agitator	ss	---	---	Induction motor used to mix tank contents.
VES-NCM-134, -135	Liquid storage tanks	304L ss	8 ft ID x 11 ft 3/16 inch shell	4000 gal	Vertical cylindrical tank, which is vented and heated and designed so that an agitator can be added at a later date. Design pressure is atmospheric and the design temperature is 150°F. The tanks are equipped with two pumps to recirculate and transfer solution.
HO-NCM-846	Calcium nitrate hopper	304L ss	6 x 4.5 ft	120 ft^3 storage	Automatic bag splitter on top. Assembly includes an elevator to lift 100 lb bags to the top of the hopper and feed them into the splitter. Empty bags are flattened, folded, and ejected out the other side into a convenient receptacle or a plastic bag. Dust is controlled within the splitter by filters vented to the room.
HO-NCE-847	Dolomite bulk storage bin	Carbon steel	114 in. dia x 22 in. straight side	---	Conical-bottom discharge; top extends through roof; 6 in. line is provided for pneumatic loading. Manual slide valve for 6 in. discharge line. Tank is vented to atmosphere to a screened 8 in. diameter line.
HO-NCM-849	Portable startup dolomite hopper	Carbon steel	4 ft dia x 5 ft high	45 ft^3 storage	Conical-bottom discharge, open-top loading, designed to be handled by forklift. A 6 in. diameter nozzle is provided on the bottom of the cone with an extension to fit the calciner loading chute in the first-level floor. The hopper is mounted on four heavy-duty casters.
ELV-NCM-946	Calcium nitrate pallet lift table	Carbon steel	4 x 6.5 x 8 ft	4400 lb	Calcium nitrate pallet lift is used to elevate bags of solid calcium nitrate to the bag splitter.
CP-NCM-9848	Calcium nitrate makeup control panel	Carbon steel	20 x 20 x 90 in. module	---	Panel houses instruments and alarms for equipment used to make up calcium nitrate.
CP-NCM-997	Liquid calcium nitrate control panel	Carbon steel	---	---	Panel houses instruments and alarms for operation and control of the liquid storage tanks (VES-NCM-134 and -135).
CP-NCE-984	Fill station meter/alarm panel	Carbon steel	---	---	Panel houses readouts and alarms for the two liquid storage tanks (VES-NCM-134 and -135).

Table 2-8. (continued).

Equipment Number	Name	Material	Dimensions	Capacity	Notes
CVR-NCM-446-2	Calcium nitrate flexible tube conveyor	304L ss	20 ft long between inlet and discharge	1,000 to 4,000 1b/h	4.5 in. OD tube; radius of curvature for tube is 20 ft; 900 rpm safety interlocks provided to prevent overloading CVR-NCM-446-1.
VIB-NCM-946	Vibrator	Carbon steel	---	< 1,000 1b force	Air-operated vibrator with variable speed control and exhaust muffler. Sized to prevent bridging and ensure free flow of calcium nitrate.
BLO-NCM-246	Calcium nitrate dust collector blower	Carbon steel	43 x 22 x 25 in.	500 cfm	A dust collector system complete with a 1 hp (500 cfm) blower and filter. An area of 120 ft^2 is provided in the hood that sits over the calcium nitrate addition area. Filtered air from this system is exhausted to the room.
CRU-NCM-900	Calcium nitrate crusher	ss	13 in. high; opening for solids is 14 x 16 in.	550 ft^3 of solids per hour	Franklin Miller Model 1075 L delumper. Powered by a 10 hp, 3-phase, 60 Hz motor rated at 460/230 V.

The maintenance area has approximately 9800 ft^2 of floorspace with an epoxy deck. The east and north walls are structural steel. The south wall is concrete to provide seismic and tornadic protection for the control room (438), the computer equipment room (439), operations offices (436 and 437), switchgear (433), and the standby generator room (432). Major components are listed in Table 2-9.

The maintenance area functions include the following: (1) providing access to the top of the process cells for maintenance purposes, (2) providing the necessary shielding to maintain radiation exposure within 0.125 mR/h at 1 ft from the "cold" face of the shield, (3) providing the workspace necessary for conducting maintenance and for removal and storage of hatch plugs, and (4) providing access in the top of the process cells for decommissioning efforts.

Pressure differentials and airflow patterns ensure airflow from areas of lesser to areas of greater contamination potential. This helps ensure that the maintenance area remains free of airborne contamination that could be created in one of the process areas.

Because the maintenance area overlies "hot" process cells, concrete shielding of sufficient thickness is required to protect plant personnel from excessive radiation exposure during normal operations. The shielding limits the maximum exposure rate at a distance of 1 ft from the floor to < 0.125 mR/h. Penetrations through shielding structures (television ports or the dolomite addition port) are provided with equivalent shielding.

2.4.3.1.9 Calciner Supply Air Plenum Room (601)—The calciner supply air plenum room, located on the second floor abovegrade, contains the equipment necessary to filter and cool or heat outside air before distribution to the second and third levels belowgrade. The NWCF stack monitor is also contained in this room. Airflow is from the second floor to ground level, to the working and access areas belowground, through the process cells, out the cell exhaust ducts to the exhaust blower [located in the calciner exhaust air plenum room (423)], through a prefilter and double HEPA filters, and out the NWCF stack.

The calciner supply air plenum room has approximately 3300 ft^2 of floorspace, a 1 ft thick concrete floor, and an epoxy deck. All walls are reinforced concrete with odorless gloss alkyd enamel finish. Major components of the room are listed in Table 2-10.

The room provides an area to house the supply portion of the calciner area H&V system. In addition, the room is able to withstand the design basis natural phenomena that could damage the room and the equipment and interrupt the confinement feature of the H&V system.

Tornadic protection is provided by a reinforced concrete structure and a tornado orifice in the calciner supply air inlet ducting. The orifice serves to limit the ΔP across the supply air HEPA filters during a DBT, preventing contamination from being sucked out of the building. The reinforced concrete prevents structural damage that could result from debris fallout or the pressure differential forces of the tornado.

The calciner supply air system consists of blowers drawing air through two plenums (HV-NCM-771-1 and -2), which are provided with two stages of filtration (a prefilter and a HEPA filter) and heating and cooling coils. Three blowers (BLO-NCM-271-1, -2, and -3), each rated at 50% of the total demand, are provided; two are in operation and one is on standby. Both of the two identical plenums are in service, each capable of supplying 80% of the normal flow-rate requirements. Thus, having two supply plenums helps to ensure continuous operation of the H&V system, at a reduced flowrate, if

Table 2-9. Maintenance area components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
CVRNCM-446-1	Calcium nitrate screw conveyor	Carbon steel and 304L ss for surfaces in contact with calcium nitrate	155 ft long from center of inlet to center of outlet	4000 lb/h	Screw-type conveyor installed to pivot from the north maintenance wall to the charging area over the blend and hold cell. Operating speed does not exceed 100 rpm.
---	Cell hatches	Reinforced concrete	4 ft thick	---	Equipped with lifting eyes. Shielded to give a radiation level of 0.125 mR/h at a distance of 1 ft from the cold face of the hatch.
CRNNCM-901	Bridge crane	Carbon steel	57 x 15 x 7 ft	30 tons	Bridge crane has a 56 ft 9 in. span and 39 ft travel. Pendant and wall-mounted controls; maintenance platform. Variable-speed control in all directions with precision positioning capability.
CRNNCM-902	PaR 3000 manipulator	Carbon steel	---	1000 lb vertical lifting capacity (shoulder hook).	PaR Model 3000 bridge-mounted manipulator with a 70-ft bridge span, 35 ft vertical travel, 130 ft T-T horizontal travel. With 1 ton auxiliary hoist, 35 ft reach.
WH1001116 WH1001117	Viewing windows	Glass	34 x 46 in. each	---	Fire-rated viewing windows.

Table 2-10. Calciner supply air plenum room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
BLO-NCM-271-1, -2, -3	calciner area air intake plenum supply blowers	Carbon steel	---	21,740 cfm at 15 in. H_20 ΔP	Centrifugal-type nonoverloading characteristic with backwardly curved airfoil blades; Air Moving and Conditioning Association (AMCA) certified rating, housing to be all-welded heavy-gauge fabricated steel with bracing; fan housing to have airtight access door with quick-opening latch; self-aligning ball bearings; variable inlet vanes for manual operation; fan with speed switch; fan statically and dynamically balanced; 75 hp, 1800 rpm, 460 V, 3-phase, 60 Hz totally enclosed fan-cooled (TEFC) motor; single inlet standard width (SISW); Class III; 40 in. minimum wheel diameter; V-belt drive sized for 150% motor nameplate horsepower.
---	Overhead beam	Carbon steel	---	2 tons	For removal of filters and blowers for transport to remote decontamination cell.
H-V-NCM-771-1, -2	Outside air intake plenum (cell area)	Carbon steel plate	16 x 30 x 9 ft	21,740 cfm per plenum	Built-up air handling unit. Painted inside and outside with epoxy. Plenum housing includes steam preheat coil with integral face and bypass controls and replaceable tubes, prefilters, air washer (95% efficiency), 1 bank of HEPA filters (24 x 24 x 11-1/2 rated 1000 scfm at 1.0 in. of W.C.), brine cooling coil, and viewports. Completely welded assemblies with provisions for aerosol testing of the HEPA filter banks. Seismically qualified for DBE.
UH-NCM-776-1, -2	Unit heaters	Carbon steel	---	198,000 Btu/h with 30 lb steam and 70°F entering air temperature 60 ft blow at 10 ft mounting height.	Steam coil unit heaters, horizontal-discharge type with safety fan guard and adjustable air deflectors, and ½ hp, 460 V, 3-phase; 60 Hz totally enclosed, thermostatically controlled fan motor.
P-NCM-271-1, -2	Air wash pumps	---	---	300 gpm at 56 ft TDH	End suction centrifugal-type pump mounted with motor on fabricated and steel base. Pump includes heavy-duty cast-iron casing, bronze-fitted, ss shaft, grease-lubricated thrust and guide, (10 year) ball bearings, stuffing box, coupling and coupling guard, drip pan, 150 psi American National Standards Institute (ANSI) standard flange connections; 5 hp, 1750 rpm, 460 V, 3-phase, 60 Hz TEFC motor.
CP-NCM-987	Local panel	Carbon steel	20 x 20 x 90 in. modules	---	Panel contains the control instruments and alarms associated with the supply air plenum equipment.
R1771-1C F1785-1, -3, -5 R1771-2C, F1785-2, -4, -6 (backup)	Calciner stack monitor	---	---	---	Instrument pulls an isokinetic sample from calciner area exhaust to detect radioactivity.

maintenance is necessary on a specific portion of one plenum. Redundant equipment, instrumentation, and standby power also help to ensure continuous operation of the calciner area supply plenum equipment.

During the winter months, a heat-saving device (HP-2601-1) is used to recover some of the heat in the exhaust air and heat the supply air.

An internal filtered and recirculating type of exhaust system is employed in the calciner supply air plenum room to ensure that the occupied areas of this room remain free of airborne contamination.

All auxiliary lines entering this room are “cold” utility lines (steam, water, etc.) and present no threat of radiation or contamination.

Fire protection features of the ventilation equipment include fire doors, dampers, sprinklers upstream of the filters, fire-resistant materials of construction, fire-resistant filters, heat detectors (TSL-1771-2-3 and -1-3) and alarms (UA-008-10 and -12), heat removal devices, and fire suppression equipment.

2.4.3.1.10 Standby Generator Room (432)—The standby generator room houses the standby diesel generators (GEN-NCM-440-1 and GEN-NCM-440-2) and associated equipment.

This area has approximately 1500 ft^2 of floorspace with a 1 ft thick concrete floor and an epoxy deck. The generators sit on an 8 ft thick concrete pad. All walls are reinforced concrete with odorless gloss alkyd enamel finish and are hardened to withstand the DBE and DBT. Major components are listed in Table 2-11.

The standby generator room functions include the following: (1) providing an area equipped with those items necessary for the operation of the standby generator, (2) providing an area protected from natural phenomena that could cause damage to the room contents and disrupt standby power, and (3) preventing contamination of the room from migration of contaminants from other areas.

This area is served by its own ventilation system. Air is drawn from inside the standby generator room and is exhausted by an exhaust fan (BLO-NCM-280) via a DBT-shielded discharge opening. A thermostatically controlled unit heater (UH-NCM-774) provides temperature control. A temperature alarm is provided to alert personnel of abnormally high or low temperatures in this area. Use of an independent ventilation system helps to ensure that this area remains free of airborne contamination that could be created in a process area. Cooling air for the generators is drawn through the roof and exhausted to the atmosphere via a DBT-hardened outlet. Dampers in the inlet and outlet fail open. Combustion air for the diesel is drawn from the room. Exhaust is routed to the outside of the building.

2.4.3.1.11 Men and Women’s Locker and Change Rooms (406 and 404)—Locker and change rooms provide toilet, locker, clothing change, and shower facilities for operating personnel and also provide an area for personnel decontamination, if necessary.

Ventilation air for these areas is drawn from the office corridor and is exhausted by a fan directly to the atmosphere. Pressure differentials, airflow patterns, and the use of separate air supply systems help maintain these areas free of airborne contamination.

Table 2-11. Standby generator room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
GEN-NCM-440-1	Diesel generator	Carbon steel	18 x 6 x 10 ft	1250 kVA, 1000 kW, 3-phase, 60 Hz, 80% power factor	2400 V alternator driven by an in-line, directly connected diesel engine at 900 rpm. For indoor service. Supply with radiator, base-mounted day tank, fuel oil transfer pump, and floor-mounted control panel. Air starting equipment, oil pressure governor, and provisions for automatic synchronizing. Equipped with static-type, solid-state voltage regulator; exhaust muffler; and air intake filter and suitable for operation at 5000 ft elevation at a temperature of 104°F max. Seismically qualified for DBE.
GEN-NCM-440-2	Diesel generator	Carbon steel	---	1250 kVA, 1000 kW, 3-phase, 60 Hz, 80% power factor	2400 V alternator driven by a diesel engine at 1800 rpm. The rest of the features are the same as GEN-NCC-440-1.
VES-NCM-137	Instrument air receiver	Carbon steel	5 x 10 ft T-T	196 ft^3	Instrument air for the NWCF is supplied via the utility tunnel and stored in VES-NCC-137 at 100 psi. This storage capacity ensures the calciner area of 15 minutes of instrument air following failure of the INTEC instrument air compressors.
P-NCM-240-1, 2	Fuel transfer pump for diesel generator	Carbon steel	---	10 gpm	Electrically powered pump for transferring fuel from the underground storage tank to the diesel generator.
BLO-NCM-280	Exhaust fan	Carbon steel	---	3000 cfm	Locally mounted exhaust fan for room ventilation. Discharge to atmosphere.
UH-FCM-774	Unit heater	Carbon steel	---	10 to 15 kW	Locally mounted electrical heater equipped with thermostat control.

2.4.3.1.12 Operations Offices (407, 436, and 437)—The operations offices provide workspace for the shift supervisor, shift foreman, and others. These areas provide operating personnel with office space that is protected from airborne contamination.

2.4.3.1.13 Calciner Exhaust Air Plenum Room (423)—The calciner exhaust air plenum room contains all NWCF ventilation exhaust equipment necessary to filter, monitor, and discharge ventilation air from all NWCF process cell areas to the NWCF stack.

The calciner exhaust air plenum room has approximately 3300 ft^2 of floorspace, a 1 ft thick concrete floor, and an epoxy deck. All walls are concrete. Major plenum room components are listed in Table 2-12.

The calciner exhaust air plenum room functions include the following: (1) providing the proper environment for operation, equipped with standby power, of exhaust air plenum room equipment and instrumentation; (2) controlling contamination by protecting NWCF H&V equipment against potential damage from natural phenomena, (3) preventing the spread of material trapped on the filters to other areas of the NWCF; (4) providing plenums that are protected against fire hazards and are easily decontaminated; and (5) providing enough area to maintain a complete backup plenum and spare blower to help ensure exhaust flow at all times.

The once-through exhaust system consists of blowers drawing air from the high-contamination areas. Three blowers (BLO-NCO-285-1, -2, and -3), each rated at 50% of the total demand, are provided, with one on standby. Two plenums (HV-NCM-785-1 and -2), each rated at 100% of system requirement, are provided. One is in service; one is on standby. This arrangement ensures continuous operation of the exhaust section of the calciner ventilation system in the event that maintenance should be necessary on a specific portion of either plenum.

The exhaust blowers are constructed of stainless steel to prevent corrosion that might result from acid-laden ventilation air (e.g., during breach of primary confinement or during decontamination activities). Additional protection is provided by an impingement plate, a prefilter, and two stages of HEPA filters that precede each exhaust blower.

Redundant equipment, control instrumentation, and standby power are provided to help ensure continuous operation of the exhaust system.

Fire protection features include fire doors, dampers, sprinklers upstream of the filters, fire-resistant materials of construction (stainless steel), fire-resistant filters, heat detectors, alarms, and fire suppression equipment.

2.4.3.1.14 Decontamination Supply Air Plenum Room (503)—The decontamination supply air plenum room houses the NWCF mechanical equipment that is necessary to provide sufficient air to the decontamination area and to the conditioning unit for the office area.

The decontamination supply air plenum room has approximately 1400 ft^2 of floorspace and a 1.5 ft thick concrete floor. The control panel for the mechanical equipment (CP-NCM-988) also is located in this room. Major components of the room are listed in Table 2-13.

Table 2-12. Calciner exhaust air plenum room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
BLO-NCO-285-1, -2, -3	Exhaust blowers	ss	---	25,000 acfm at 13.0 in. actual setpoint per blower	Air blower with centrifugal-type nonoverloading capability and backwardly curved single- or double-thickness airfoil blades; Air Moving and Conditioning Association (AMCA) certified rating; housing and wheel are all-welded steel with bracing; fan housing has airtight access door with quick-opening latch; self-aligning ball bearings have variable inlet vanes for automatic operation with diaphragm operator; fan has centrifugal speed switch and is statically and dynamically balanced; 75 hp, 1800 rpm, 460 V, 3-phase, 60 Hz totally enclosed fan-cooled (TEFC) motor; single inlet standard width (SISW), Class IV, arr., 35-1/2 in. minimum wheel diameter; V-belt drive-sized for 150% motor nameplate guard and spring-mounted inertia isolation base.
HV-NCO-785-1, -2	Ventilation exhaust plenums	All-welded construction to be carbon steel painted inside and out with epoxy paint	28 x 16 x 15 ft	50,000 acfm	Built-up air handling units; plenum housing includes view ports, impingement plates, cooldown chamber, moisture separator prefilter, two banks of HEPA filters (24 x 24 x 11-1/2 rated at 1,500 scfm at 1.0 in. of W.C.), and transfer trolleys. Plenum assembly includes provisions for individual testing of each HEPA filter bank. Unit to be seismically qualified for DBE.
CP-NCM-985	Control panel	Carbon steel	20 x 20 x 90 in. modules	---	Contains the control instrumentation and local alarms for calciner exhaust air plenum room equipment.

Table 2-13. Decontamination supply air plenum room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
HV-VCD-786	Decontamination supply plenum	Galvanized steel	32 x 24 ft	69,000 cfm	Plenum houses preheaters, prefilters, evaporative, cooler, heating coils, etc.
BLO-NCD-286	Blower	Carbon steel	---	61,360 cfm	Blower supplies motive force for ventilation air to the first level.
---	Monorail	Carbon steel	---	---	Monorail is provided to aid in removal of the supply blower for maintenance needs.
CP-NCM-988	Control panel	Carbon steel	20 x 20 x 90 in. modules	---	

The decontamination supply air plenum room functions include the following: (1) providing the proper environment (temperature, etc.) for the operation of the decontamination supply air plenum equipment, (2) controlling contamination by protecting decontamination equipment against damage from natural phenomena, and (3) preventing the contamination of other parts of the decontamination area H&V system from the infiltration of contamination into the room.

Ventilation to the room is supplied by the supply air plenum. The plenum is equipped with a roughing filter (AF-786-1), an evaporative cooler (EC-786-1), and a blower (BLO-NCD-286). Supply air is drawn from the outside via a louvered opening in the south wall of the room. The room has an overhead wet-pipe sprinkler system for fire protection.

2.4.3.1.15 Decontamination Exhaust Air Plenum Room (426)—The decontamination exhaust air plenum room contains the exhaust air plenums (HV-NCD-787-1 and -2), blowers (BLO-NCD-287-1 and -2), the local control panel (CP-NCM-986), and the associated piping necessary for exhausting the air from the abovegrade areas to the NWCF stack.

The decontamination exhaust air plenum room has approximately 2800 ft^2 of floorspace and a 2 ft thick concrete floor. All walls are concrete and structural steel. Major components of the room are listed in Table 2-14.

The decontamination exhaust air plenum room functions include the following: (1) providing the proper environment for the operation of the exhaust equipment, (2) containing any contamination released from the plenums and blowers, and (3) protecting the decontamination equipment against damage from natural phenomena.

Ventilation air is supplied to the room by the decontamination area H&V system. The room air is pulled back into the exhaust plenum where the air passes through a roughing filter and two HEPA filters all in series. The air is then exhausted to the outside atmosphere.

The walls of the room provide adequate radiation shielding if the filters are changed as required.

2.4.3.1.16 Nitric Acid Recycle Tank Vault (443)—The nitric acid recycle tank vault contains the nitric acid recycle tank (VES-NCR-171), the nitric acid recycle head tank (VES-NCR-173) and associated piping, a steam unit heater, an acid sensor for personnel protection, an airlift (AL-NCR-550), and a sump with a steam jet (JET-NCR-506). The equipment receives recycled < 13 M nitric acid from the LET&D system and supplies it to the off-gas wet scrub system in place of fresh 13 M nitric acid.

The vault is approximately 715 ft^2 and contains a 22,500 gal nitric acid recycle tank, an 80 gal head tank, an airlift, and a steam jet. The nitric acid recycle tank is a horizontal cylindrical vessel constructed of Type 304L stainless steel. The tank measures 11 feet 1.75 in. in diameter and 33 feet 8 in. long with a wall thickness of 0.875 in. The tank contains low-level radioactive nitric acid < 13 M. The head tank is a vertical cylinder constructed of 24 in. Schedule 40 Type 304L stainless steel pipe with a wall thickness of 0.678 in. The head tank has 0.375 in. thick Type 304L stainless steel plate ends. The head tank measures 4 feet 8 in. tall. The vault has three 8 in. concrete walls, and an 8 in. concrete block wall on the northwall of the vault, which is on the south side of the decontamination area. The vault is lined to a height of 56 in. with Type 304L stainless steel to provide containment for 110% of the tank volume plus 20 minutes of firewater flow at 570 gpm.

Table 2-14. Decontamination exhaust air plenum room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
HV-NCD-787-1, -2	Exhaust air plenums	Carbon steel with epoxy paint inside and outside	38 x 26 ft	62,000 cfm	Two plenums, each operated at 50% of rated capacity. Each plenum has a prefilter and two banks of HEPA filters.
BLO-NCD287-1, -2	Blowers	Carbon steel	9 x 6 x 8 ft	30,000 cfm	Centrifugal type air blowers with backwardly curved single- or double-thickness airfoil blades with welded steel housing. Housing has airtight access door with quick-opening latch, self-aligning ball bearings, fans supplied with centrifugal speed switches and statically and dynamically balanced. 75 hp, 1,800 rpm, 460 V, 3-phase; 60 Hz totally enclosed fan-cooled (TEFC) motor; single inlet standard width (SISW); Class III; 44 in. minimum wheel diameter; V-belt drive-sized for 1505 sheave; belt guard; and spring-mounted inertia isolation base.
CP-NCM-986	Local control panel	Carbon steel	20 x 20 x 90 in.	---	Contains the instruments and alarms associated with the operation and control of the exhaust air plenum room equipment.

The vault functions include the following: (1) providing a minimum ambient air temperature of 20°C (68°F), (2) minimizing the potential for the spread of contamination at the decontamination room entrance with a double-door entry, buffer zone, (3) providing radiation shielding to protect personnel located in full-time occupancy areas, and (4) protecting vault equipment from natural phenomena.

2.4.3.1.17 Miscellaneous First-Level Features—Twelve entryways (personnel and equipment) serve the NWCF building. Primary personnel access is gained from entry 401 on the south side of the building. Secondary exits are provided on the building's north, east, and south sides.

The building contains a freight elevator and three stairways. The freight elevator is hydraulically operated with approximately 100 ft^2 of floorspace and a 10,000 lb lifting capacity. This elevator, located in the southeast quadrant of the building, provides access to all lower levels except the hot sump vault level.

Stairway no. 1, located near the elevator shaft, provides access to the same areas as the elevator. Stairway no. 2, located on the north side of the building, provides direct access to each level except the hot sump tank cell level. Stairway no. 3 leads from the low-level decontamination room to the remote decontamination cell operating area and down to the third level.

A miscellaneous storage area and a janitorial storage closet are also provided on the first level.

2.4.3.1.18 Contaminated Equipment Maintenance Building (CPP-1659)— Contaminated Equipment Maintenance Building (CPP-1659) is attached to the west outside wall of the NWCF and provides support area to the calcining process. The building is 32 ft by 50 ft by 25 ft high. It is constructed of steel-reinforced concrete with a metal roof. The interior floor has a stainless-steel liner extending 6 in. up the inside walls. A stainless-steel trench is drained to the NWCF waste holding vessel (VES-NCD-123). All other surfaces are epoxy finished to aid in area decontamination. The building has a roll-up door leading east into the truck bay. The northeast corner of the building has a door to the truck bay. An emergency exit door on the south wall opens to the outside of the building. The building is designed to the UBC code seismic requirements at the time of construction.

Building ventilation air enters from the south wall and is HEPA filtered when leaving the building to the NWCF HVAC system. The building is protected with a wet-pipe sprinkler system. Steam, raw water, plant air, and 120, 220, and 480 VAC electrical power utilities are available in the building from the NWCF supplies. The building has fire alarms, evacuation alarms, and public address system.

2.4.3.2 Second Level. The second level lies 17 ft below the first level and 13 ft belowgrade at a reference elevation of 4900 ft above sea level. The second level provides access to the off-gas blower cell (322), the remote decontamination cell (308), the filter handling cell (309), the ventilation air cleanup cell (305), the auxiliary off-gas blower cell (304), the flowmeter cubicle (314), the utility room (324), the utility corridor (325), the equipment decontamination storage area (306), the gas and liquid sampling cell (320), the fluidizing air blower room (315), and the fluidizing air preheater room (316). In addition, this level contains instrument transmitters (many enclosed in drained and vented metal transmitter cabinets) and a personnel decontamination room. Three stairways and a freight elevator serve this level as well as the levels above and below. Ventilation control is provided to maintain the proper pressure differentials between the process areas and the corridors. A self-monitoring and personnel decontamination station (319) is located on this level near stairway no. 2 for personnel protection and contamination control. Double-door passageways (similar to an airlock) are provided at the stairways, the service opening, and cell entryways to help minimize the spread of contamination should an accidental release occur.

Shielding is provided between the upper levels of the adjacent process cells, equipment rooms, valve cubicle, and the "hot" process areas below by concrete walls and floors of sufficient thickness to reduce radiation levels to < 0.125 mR/h at a distance of 1 ft from the shielding. Chapter 7 of this safety analysis presents a complete discussion of shielding.

2.4.3.2.1 Fluidizing Air Blower Room (315)—The fluidizing air blower room contains two fluidizing air (and transport air) blowers (BLO-NCO-205-1 and -2) and associated piping and instruments. These blowers provide air for bed fluidization in the calciner vessel and motive air for transporting solids to storage.

The fluidizing air blower room has approximately 250 ft^2 of floorspace and 1.5 ft thick concrete walls and floor. All walls, floor, and ceiling are epoxy-coated. Access is provided on the second level. Major components are listed in Table 2-15.

The fluidizing air blower room functions include the following: (1) providing a suitable environment to ensure the proper operation of the blowers, (2) providing noise isolation and fire protection for the blowers, and (3) preventing the spread of contamination from the equipment contained in the room.

This room is served by the calciner area H&V system. Airflow patterns and pressure differentials prevent the infiltration of contamination from contaminated areas. An overhead wet-pipe sprinkler system provides fire protection. A floor drain to the nonfluoride hot sump tank (VES-NCC-122) is also provided for this room.

2.4.3.2.2 Off-Gas Blower Cell (322)—The off-gas blower cell contains the POG blowers (BLO-NCC-243-1 and -2) and associated piping that maintain a vacuum on the NWCF off-gas cleanup and equipment vent systems during operation of the calcination process. Control of the off-gas vacuum and equipment vent systems is maintained from the control room and is discussed in Section 2.6.

The off-gas blower cell has approximately 950 ft^2 of floorspace, a 1.5 ft thick concrete floor with a stainless steel deck, and a 3 ft wainscot. Hatches are provided in the ceiling to facilitate blower removal, repair, or replacement. All walls are reinforced concrete with epoxy finish above the wainscot. Major components are listed in Table 2-16.

The off-gas blower cell functions include the following: (1) providing a suitable environment for operation of the off-gas blower equipment, (2) helping to ensure continuous process operations by providing easy access to the cell for maintenance purposes and standby power, (3) containing in the cell any radioactive material released from the off-gas system and permitting decontamination, (4) providing adequate radiation shielding to protect personnel located in full-time-occupancy areas, and (5) providing adequate noise isolation for plant personnel located in full-time-occupancy areas.

Redundant equipment, control instrumentation, and standby power help ensure continuous positive displacement of NWCF POG from the cleanup and equipment vent systems. During normal operation, vacuum in the POG and in the equipment vent systems is maintained by one of the pair of off-gas blowers in parallel service. Vacuum control is discussed in Section 2.6. Each off-gas blower is made of stainless steel to prevent excessive corrosion from the acid-laden off-gases and is equipped with a decontamination system to reduce radiation dose rates and facilitate removal for repair or replacement. This cell is provided with a wet-pipe sprinkler system for fire protection.

Table 2-15. Fluidizing air blower room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
BLO-NCA-205-1, -2	Fluidizing air blower	Carbon steel	---	1008 cfm	Single-stage positive-displacement compressor, inlet pressure of 12 psia, discharge pressure of 17.7 psia.
F-NCO-105-1, -2	Inlet filter silencers	Carbon steel	---	---	
MU-NCO-905-1, -2	Discharge mufflers	Carbon steel	---	---	
F-NCO-106	Fluidizing air oil separator	Carbon steel	---	800 cfm	

Table 2-16. Off-gas blower cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
BLO-NCC-243-1, -2	Off-gas blower	Type 304L ss internals	---	2000 scfm per blower at 12.25 psia and 194°F	Gas molecular weight: 26.43; discharge pressure: 12.6 psia; blower to be equipped with decontamination system.
HE-NCC-343-1, -2	Off-gas blower intercooler	Type 304L ss internals	---	345,000 Btu/h	Intercooler provides the required heat sink for process off-gas as it is compressed by an off-gas blower (BLO-NCC-243-1).
VES-NCC-143-1, -2	Intercooler knockout drum	Type 304L ss	42 in. ID x 4 ft 6 in. T-T	---	Intercooler knockout drum collects condensate that drains from intercooler.
VES-NCC-144-1, -2	Lube oil coast down tanks	---	---	---	

An auxiliary blower with a smaller capacity is provided to maintain a vacuum on the system during routine shutdowns or during an abnormal event that would cause both off-gas blowers to stop. The auxiliary blower is located in another room.

2.4.3.2.3 Fluidizing Air Preheater Room (316)—The fluidizing air preheater room houses two electrical resistance-type heaters (HTR-NCO-305-1 and -2) and associated piping to supply heated air for fluidizing the calciner bed. The fluidizing air preheater room is located as close as practical to the calciner cell to minimize heat loss. The entryway on the second level provides access for heater maintenance, removal, and replacement.

Heater and fluidizing air temperature controls are discussed in Section 2.5. Instrumentation to control the return jets (JET-NCC-505-1 and -2) also is located in this area.

The fluidizing air preheater room has approximately 250 ft^2 of floorspace, a 1 ft thick concrete floor, and an epoxy deck. All walls are reinforced concrete with an odorless semigloss alkyd enamel covering. Listed in Table 2-17 are the major components of the fluidized air preheater room.

The fluidizing air preheater room functions include the following: (1) providing the proper environment (temperature, etc.) for the operation of preheater equipment, (2) protecting the equipment from fire or physical damage that could impair the functioning of the off-gas system, and (3) isolating the equipment from plant personnel to mitigate hazards of equipment failures.

Two fluidizing air heaters ensure a constant supply of hot fluidizing air during normal operation. Automatic shutdown circuitry is incorporated into the fluidizing air preheater control system to prevent heater burnout from low fluidizing airflow or high element temperature. Fire protection of this room is provided by an overhead wet-pipe sprinkler system.

2.4.3.2.4 Valve Cubicle and Filter Cell (216)—A shielded valve cubicle and filter cell are located on the north side of the blend and hold cell and the adsorber cell. The valve cubicle and filter cell are used for storage of NWCF filters until they can be processed through the filter-leach system.

The cubicle contains items that are expected to require high maintenance (primarily process valves). The west half of the cubicle contains the valves for the adsorber cell and the east half contains the valves for the blend and hold cell. East side access to the valve cubicle is gained from entry 213, and west side access is gained from the filter cell (216) via the manipulator parking and maintenance area (218). An airlift pit is provided in the valve cubicle to attain the submergence required to airlift solutions from the blend tank (VES-NCC-101), to the hold tanks (VES-NCC-102 and -103), to the HLLWE feed tank (VES-NCC-152) and to the feed tank (VES-NCC-104).

The valve cubicle and filter cell are approximately 60 ft long, 11.5 ft wide, and 34 ft high. Eight viewing windows penetrate the north wall (four at each level). These windows are located to provide adequate viewing for all remote operations conducted in the cubicle. A wall-mounted PaR manipulator (CRN-NCC-914) is located on the north wall, and an overhead 1 ton crane (CRN-NCC-902) provides remote service for the valve cubicle and filter cell. The floor and the entire south wall of the valve cubicle are covered with a stainless steel liner. Overhead hatches are provided to facilitate use of the 30-ton bridge crane (CRN-NCM-901) and a bridge-mounted PaR (CRN-NCM-902) if it is necessary. The 1 ton crane (CRN-NCC-902), which is located in the valve cubicle and traverses the length of the cubicle, extends into the crane maintenance area. Major components of the cubicle and cell are listed in Table 2-18.

Table 2-17. Fluidizing air preheater room components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
HTR-NCO-305-1, -2, -3, -4,	Fluidizing air preheaters	304L ss	6 ft long x 3 in.	862,000 Btu/h	Electrical resistance Incoloy-sheathed heater elements. $\Delta T = 927°F$.
HTR-NCO-315-1, -2	Dilution air heaters	304L ss	1 in. in dia x 2 ft	8 to 10 Btu/h	Electrical resistance Incoloysheathed heater elements. $\Delta T = 211°F$.

Table 2-18. Valve cubicle and filter cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
---	Process valves	316 ss	---	---	Equipped with remote disconnects for remote removal and maintenance.
CRN-NCC-902	Bridge crane	Carbon steel	---	1 ton	To help transport contaminated items from the valve cubicle to either the remote decontamination cell or filter handling cell.
CRN-NCC-914	Electro-mechanical manipulator	ss	---	150 lb	Wall-mounted PaR Model 3000; 110 ft horizontal travel; 34 ft vertical travel; 10 to 12 ft horizontal reach.
LGW-NCO-908-1, -2, -3 LGW-NCA-911-1, -2, -3	Valve cubicle shielded viewing windows	Lead glass	3 x 4 ft, varies from window to window	120 degree view angle	Three windows are on the second-level N operating corridor and three windows are on the third-level N access corridor.
LGW-NCO-079	Transfer area shielded viewing window	Lead glass	Varies from window	120 degree view angle	Small window on east end of valve cubicle.
LGW-NCO-910-2 LGW-NCA-910-1	Filter cell shielded viewing window	Lead glass	Varies	120 degree view angle	One window is on the second-level N operating corridor and one window is on the third-level N access corridor.
	Tool ports	ss	6 in. ID	---	Specially designed tool ports extend through the shielding walls near the master-slave manipulators and shielding windows.
	Airlift pit	Reinforced concrete with ss liner	6 x 12 x 16 ft	---	Pit provides the required submergence to airlift waste solution from the blend and hold tanks (VES-NCC-101, -102, and -103) to the calciner feed tank (VES-NCC-104).

The valve cubicle functions include the following: (1) providing an area for high maintenance items to be remotely handled and worked on, (2) controlling contamination anticipated for remote work in the cubicle, (3) permitting easy decontamination of the cubicle, and (4) providing adequate radiation shielding for personnel working outside the cubicle in full-time-occupancy areas.

Ventilation air is supplied from the first level by a branch duct of the calciner supply air to the blend and hold cell. The airflow is from the valve cubicle to the filter cell to the calciner area exhaust plenum.

Overhead shielding provided by the ceiling and associated hatches is adequate to reduce the maximum radiation exposure rate to 0.125 mR/h at 1 ft from the cold face of the shielding structure. Shielding for the second- and third-level corridors is provided by the 4 ft thick concrete walls. These concrete walls reduce the maximum radiation exposure rates to 0.125 mR/h at a distance of 1 ft from the cold face of a shielding structure. Viewing windows provide shielding commensurate with the walls.

All wetted parts on valves, flowmeters, piping, etc., are fabricated from stainless steel to prevent excessive corrosion from process streams and decontamination.

The valve cubicle is equipped with remote decontamination capabilities (hose connections, sprays, etc.) to facilitate remote decontamination of equipment should direct maintenance or equipment removal become necessary. Because this cubicle contains no combustibles, no sprinkler system is provided for fire protection. The decontamination spray system could be used to provide fire protection.

2.4.3.2.5 Filter Handling Cell (309)—The filter-leaching system was designed to be remotely operated in the filter handling cell (see Figure 2-7). This system processes contaminated filters from the NWCF filter cell and from other INEEL facilities. The filters that are processed may be contaminated with mixed fission products, fissile material and transuranic (TRU) waste, hazardous chemical waste, or mixed hazardous waste. Depending on the process area of origin and their radiation levels, the filters may be handled manually or by remote means. The filters are transported in containers ranging from a plastic bag contained in a 55 gal drum to specially designed filter containers that are themselves contained in shielded casks. The filter-leach process involves acid leaching, liquid waste handling, rinsing, drying, and packaging for disposal at the Radioactive Waste Management Complex (RWMC).

The filter handling cell has approximately 330 ft^2 of floorspace with 3 ft thick high-density concrete exterior shielding walls (to a height of 8 ft) and a 12 in. thick concrete floor that rests on a 3 ft thick foundation. The shielding window in the cell is equivalent to 3 ft of ordinary concrete. A stainless steel liner is provided for the entire cell. Cell access is gained through a two-door airlock entryway (307) into the adjacent decontamination cell, a ceiling hatch with a transfer port to accommodate Fluorinel Dissolution Process and Fuel Storage (FAST) or Remote Analytical Laboratory (RAL) bottom loading casks, and a vertical door through the crane maintenance and transfer area. A floor drain is installed to allow solutions to drain to either the decontamination area holdup tank (VES-NCD-123) or the decontamination solution collection tank (VES-NCD-129).

The filter handling cell contains the necessary equipment to process filters that are contaminated with fissile radioactive waste including TRU waste, hazardous waste, or mixed waste. Process equipment includes a 115 gal filter leaching vessel (VES-NCD-141), a 69 gal filter drying vessel (VES-NCD-142), filter processing baskets, master-slave manipulators (MAN-NCD-909-1 and -2), an electromechanical manipulator (CRN-NCD-905), a 5 ton crane (CRN-NCD-912), a leached filter storage and work table, a lid stand, and a drain basket. The drain basket traps particulate from the leaching vessel while it drains to either the holdup tank (VES-NCD-123) or the collection tank (VES-NCD-129). There are redundant sample lines from the filter leaching vessel (VES-NCD-141) to the NWCF liquid sample system.

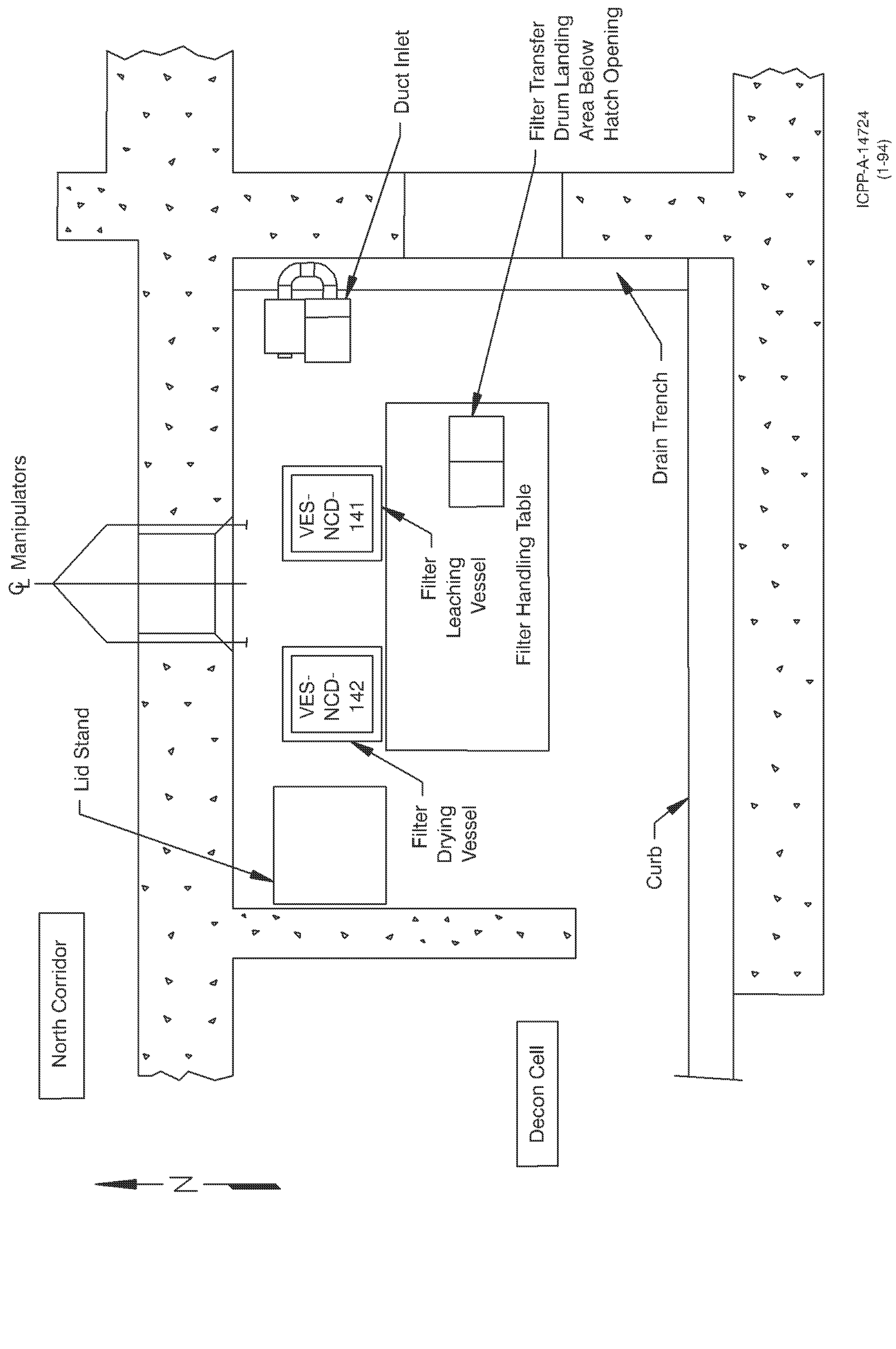


Figure 2-7. Plan view of the Filter-Leaching System.

Decontamination solution (nitric acid), water, air, and steam are supplied to the cell. The filters are remotely transferred from shipping casks or from appropriate containers as required. Major components of the cell are listed in Table 2-19, and their in-cell arrangement is illustrated in Figures 2-7, 2-8, and 2-9.

The filter handling cell functions include the following: (1) providing an area to remotely decontaminate filters to the low-level waste (LLW) acceptance criteria and package the waste into LLW boxes for disposal at the RWMC, (2) providing adequate fire protection and radiation shielding to protect the personnel operating the equipment in the cell and all other personnel in full-time-occupancy areas, (3) preventing the radioactivity contained in the cell from migrating to clean areas of the NWCF, and (4) permitting easy decontamination of the area because surfaces are covered with stainless steel.

Overhead shielding is provided by removable roof hatches that reduce radiation exposure rates in the equipment decontamination room to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure. Exterior shielding is provided by concrete walls or partitions (e.g., labyrinth-type passageways). Radiation exposure rates for cell exteriors (i.e., operating areas) are less than 0.125 mR/h at a distance of 1 ft from the cold face of any shielding structure. The shielding walls and ceiling were designed to provide personnel protection from a radiation source with gamma fields of 100 R/h at 1 ft (E $\gamma \sim 1.25$ MeV). High-density concrete (220 lb/ft^3) is used to a height of 8 ft in the exterior walls.

The filter-leaching equipment drains to either the holdup tank (VES-NCD-123) or the decontamination solution collection tank (VES-NCD-129). The cell floor drains provide collection of any liquid spills.

Removable roof hatches are provided to facilitate placement and removal of filter casks and associated equipment. A shielding window and a pair of master-slave manipulators are provided for remote filter handling and packaging activities.

Fire protection is provided by a cross-zoned deluge system. The deluge system automatically activates when detectors are activated in both zones. Each shielding window has two thermocouples (TCs) located near each window, one for each zone. Activation of a detector in the first zone sets off an alarm on the fire protection panel (MIP-10) located on the north wall of the control room (438). The deluge control panel is located near the waterflow valve on the second level. Waterflow is terminated by closing a block valve in the supply line.

Internal decontamination of the filter handling cell is facilitated by decontamination headers and sprays. In addition, portable high-pressure spray equipment can be used when required by radiation levels.

The functions of the filter handling cell, which contains equipment for remote decontamination of highly contaminated filters, include the following: (1) reducing radioactive waste, hazardous waste, or mixed hazardous waste to non-TRU and nonhazardous LLW; (2) achieving ALARA objectives by minimizing personnel radiation exposures on a per-filter-handled basis; and (3) reducing the total activity sent to the RWMC.

Table 2-19. Filter handling cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCD-141	Filter leach vessel	300 series ss	29 x 35 x 26.25 in.	115 gal	Remotely operated leaching vessel; loading and unloading with remote equipment. Leaching and rinsing operations are performed in the vessel.
MAN-NCD-909-1, -2	Master-slave manipulators	Carbon steel covered by plastic sleeve	---	---	Master-slave manipulators mounted through 3 ft-thick cell wall. Manipulate filters during leaching operations. Package leached filters.
LGW-NCD-903	Shielding window	Lead glass	22 x 26 in.	---	Oil-filled lead-glass window in 3 ft thick walls with maximum viewing angle.
CRN-NCD-912	Bridge crane	Carbon steel	---	---	Move process filters from crane maintenance area to filter handling cell. Lift 30 ft. Remote control hoist/trolley. Load capacity 5 tons. Also serves remote decontamination cell.
---	Lid stand	300 series ss	46 x 44 x 18 in.	---	Used to store vessel lids during loading and unloading operations.
---	Filter storage table	ss	129 x 60 x 42 in.	---	Used to store filters after leaching, prior to packaging.
---	Filter leach basket	300 series ss	Sized to hold filters as required	---	Used to contain contaminated filters during leaching process.
---	Sample bottle stand	ss	---	---	Used to position sample bottles to draw leach and rinse samples.
CRN-NCD-901	Bridge crane	Carbon steel	---	---	Move filters from crane maintenance area to filter handling cell. Has two hooks, load capacity of 30 tons. Has a 5 ton auxiliary hoist.
CRN-NCD-905	Electro-mechanical manipulator	Carbon steel	---	---	PaR Mod 3000. Manipulate filters during decontamination and packaging. Also serves remote decontamination cell.
VES-NCD-142	Filter drying vessel	300 series ss	34.75 x 28.75 x 16 in.	69 gal	Remotely operated heated filter drying vessel. Final drying of filters performed in the vessel.

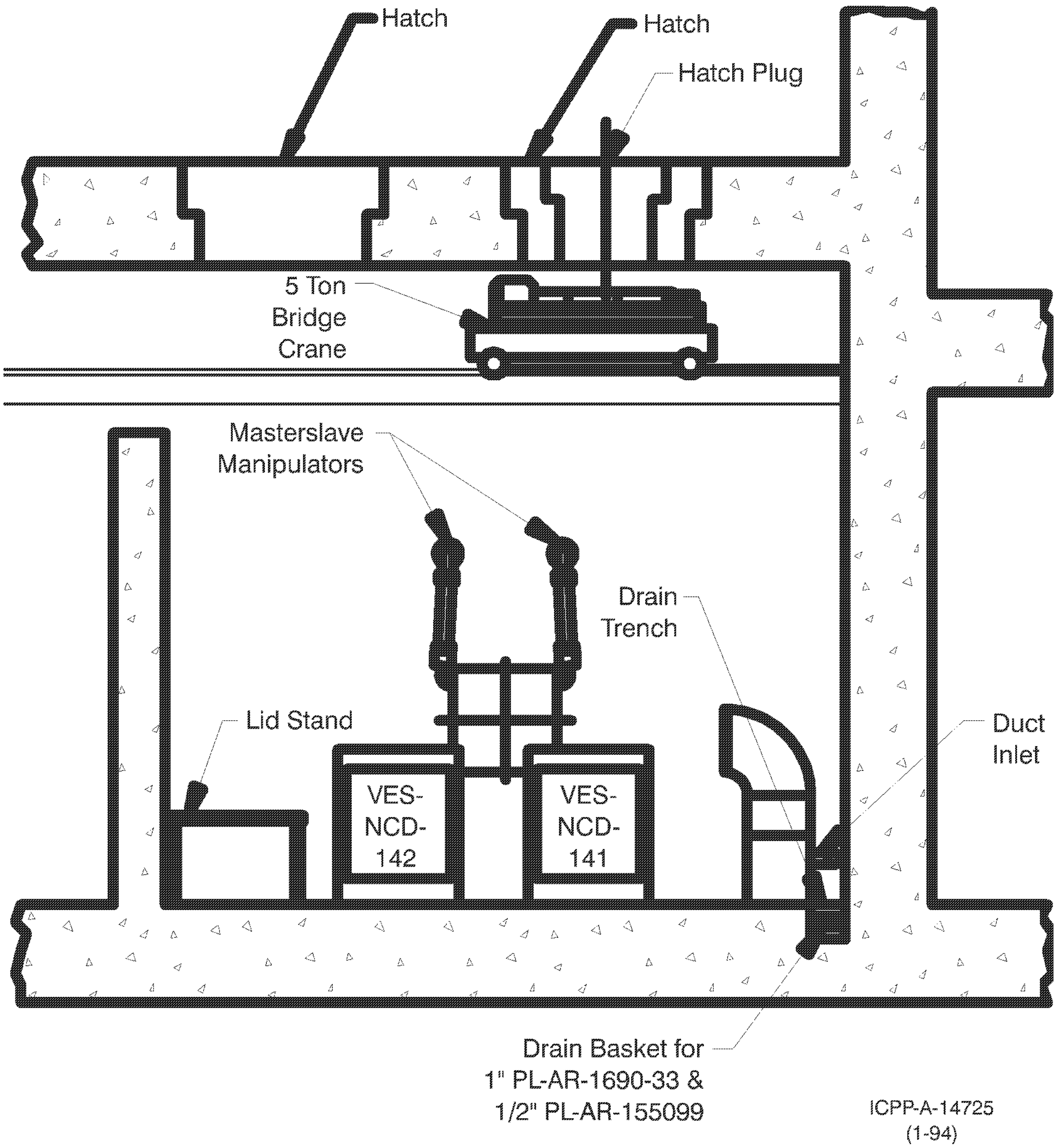


Figure 2-8. Back-to-front view of the Filter Leaching System (facing north).

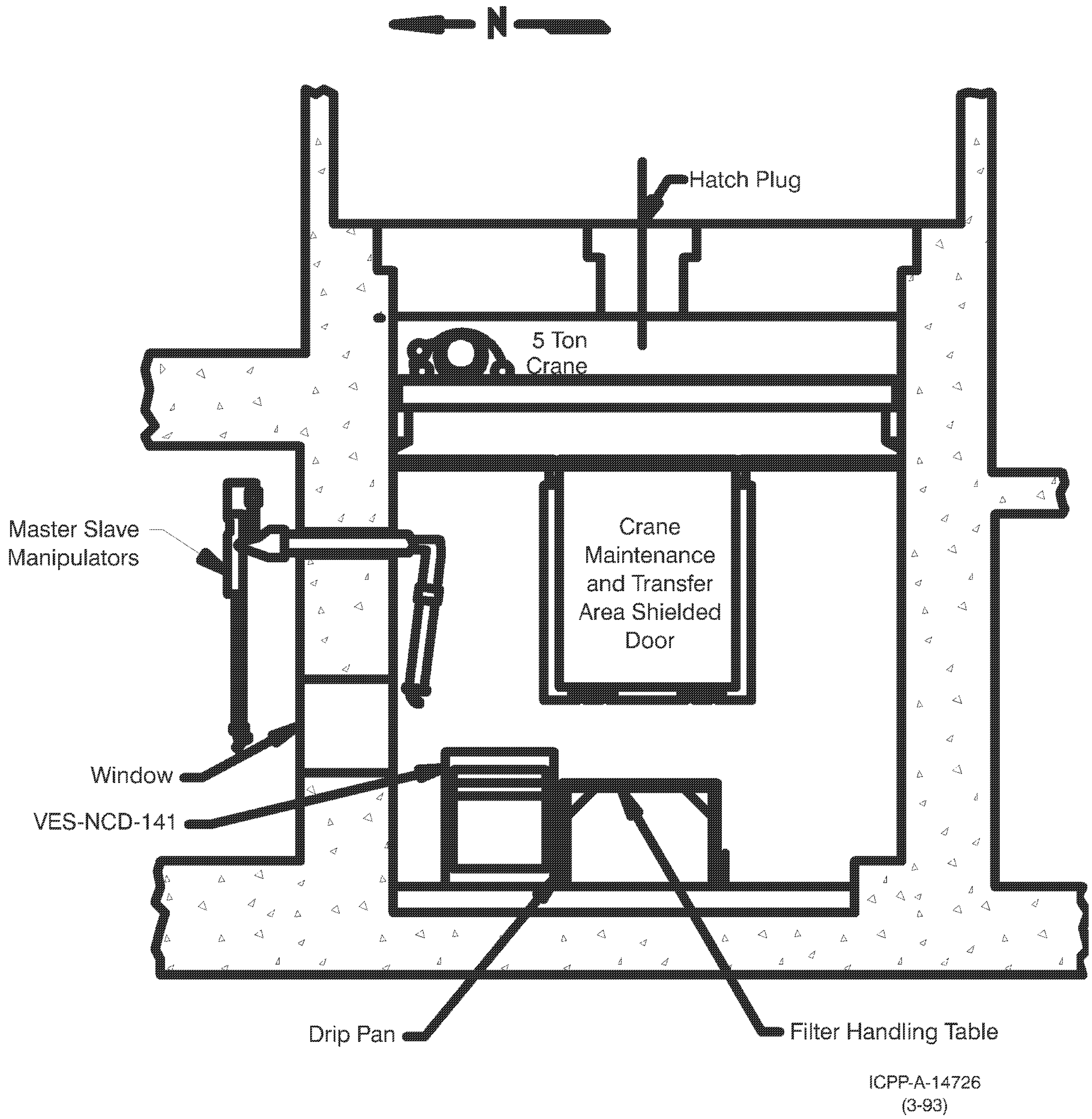


Figure 2-9. Side view of the Filter-Leaching System.

2.4.3.2.6 Remote Decontamination Cell (308)—The remote decontamination cell provides an area for decontamination and preliminary disassembly of highly contaminated equipment while minimizing personnel radiation exposures.

The remote decontamination cell has approximately 380 ft^2 of floorspace with 3 ft thick high-density concrete shielding walls up to 8 ft high and a 1 ft thick concrete floor. Stainless steel lines the entire cell. Access is gained through two doorways in entry 307 located on the south side of the cell. The cell has three shielding windows.

Items to be disassembled and decontaminated such as pumps, valves, heat exchangers, etc., are lowered into the cell through hatches in the roof or moved into the cell by the overhead cell crane from the valve cubicle area. The interior of the cell is observed through three shielding windows, two in the north wall and one in the west wall. Equipment provided for remote in-cell work includes an overhead bridge crane; three pairs of master-slave manipulators; an electromechanical manipulator; a turntable; and portable soak tanks and spray wands for decontamination solutions, steam, and water. The spray wands are able to be connected to a high-pressure pump (10,000 psi) for cell and equipment decontamination. Major components of the cell are listed in Table 2-20.

The remote decontamination cell functions include the following: (1) providing an area equipped and devoted to remote decontamination work, (2) providing adequate radiation shielding to protect personnel from contaminated items in the cell, (3) preventing the spread of any contamination removed during the decontamination work in the cell to clean areas, (4) providing a means of loading items to be decontaminated into the cell, and (5) permitting easy decontamination of the cell surfaces because surfaces are covered by stainless steel.

Overhead shielding is provided by concrete roof hatches that reduce radiation exposure rates in the equipment decontamination room to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding wall. Shielding for the adjoining operating corridor is provided by high-density (220 lb/ft^2) concrete in the cell and labyrinth walls. The high-density concrete extends to a height of 8 ft. Radiation exposure rates are reduced to < 0.125 mR/h at a distance of 1 ft from the cold face of a shielding wall or shielding window.

A sump floor drain system with grating is used to route decontamination solutions to either the holdup tank (VES-NCD-123), or the collection tank (VES-NCD-129) to provide collection and containment of all contaminated solutions. Solutions can be transferred from the holdup or the collection tank to the hot sump tanks (VES-NCC-119 and -122), PEW evaporator, the blend tank (VES-VCC-101), hold tanks (VES-NCC-102 and -103), or the Tank Farm, depending on the fluoride and radiochemical content.

Internal decontamination of the remote decontamination cell is facilitated by decontamination headers and sprays. In addition, portable high pressure (10,000 psi) spray equipment is used for contaminated areas that are especially difficult to clean.

The H&V pressure differentials and flow patterns ensure that airflow is into the cell. This ensures that no radiological contamination leaves the cell.

Fire protection for this cell is provided by spray heads located around the perimeter of the cell. The heads are connected to a wet-pipe system and are activated manually. Once activated, water continues to flow until the manual block valve is closed.

Table 2-20. Remote decontamination cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
LGW-NCD-902-1, -2, -3	Shielding windows	Lead glass	20 x 28 in.	---	Oil-filled lead-glass window in 3 ft thick cell walls with maximum viewing angle.
CRN-NCD-905	Electro-mechanical manipulator	Ss	---	150 lb	PaR Mod 3000. Manipulates pieces of equipment during decontamination activities. Also serves filter handling cell.
MAN-NCD-906-1, -2, MAN-NCD-907-1, -2, MAN-NCD-908-1, -2	Master-slave manipulator	Ss	---	50 lb	Master-slave manipulators mounted through 3 ft thick cell wall
TD-NCD-915-1	Turntable	Ss	2 x 8 ft in dia	2 tons	Turntable rotated by a built-in motor. Sealed bearings.
CRN-NCD-912	Bridge crane	Carbon steel	---	5 tons	Crane is used to lift, move, and position items to be decontaminated. Lifts 30 ft remote control hoist/trolley. Load capacity 5 tons. Also serves filter handling cell.

2.4.3.2.7 Auxiliary Off-Gas Blower Cell (304)—A small auxiliary off-gas blower (BLO-NCC-242) is contained in this cell along with associated piping and valving to maintain a negative pressure on the process equipment whenever both of the main POG blowers are not operating.

This auxiliary off-gas blower cell has approximately 130 ft^2 of floorspace, 1 ft thick concrete walls, and a 1 ft thick concrete floor. Stainless steel lines the floor of the cell and the lower 6 in. of the walls. The rest of the cell is epoxy-coated. A floor drain with a stainless steel grating drains solutions to the hot sump tank cell.

The main component in the cell is the blower, which has a capacity of 990 scfm. The inlet temperature and pressure are 85°F and 11.1 psia, respectively. Discharge pressure is 12.6 psia. The internals of the blower are Type 316 stainless steel with provisions for decontamination.

The auxiliary off-gas blower cell functions include the following: (1) providing the proper environment for the operation of the blower; (2) containing any contamination released from the off-gas blower; (3) providing the radiation shielding necessary to protect workers from activity contained in the blower, piping, and the cell; (4) isolating the blower noise from plant personnel; and (5) permitting easy decontamination of the cell surfaces because surfaces are covered by stainless steel and epoxy paint.

2.4.3.2.8 Ventilation Air Cleanup Cell (305)—The ventilation air cleanup cell contains the air scrubber assembly (ASA-NCD-929). The air scrubber assembly cleans the exhaust air from the remote decontamination cell, the filter handling cell, and many of the decontamination components located on the first level. The control features of this equipment are discussed in Section 2.6.

This area has approximately 320 ft^2 of floorspace, 1 ft thick concrete walls, and a 1 ft thick concrete floor lined with stainless steel. Unlined portions of the cell are epoxy-coated. A floor drain with a stainless steel grating is installed to drain solutions to the nonfluoride hot sump tank (VES-NCC-122).

The ventilation air cleanup cell (305) contains a scrubber (ASA-NCD-929), a recirculation pump (P-NCD-226), and a scrub solution tank (VES-NCD-126). The scrubber also contains a built-in mist eliminator pad in the upper section of the scrubber. This equipment removes moisture and particulate entrained in the ventilation exhaust gases from the decontamination cubicles (421 and 422), the remote decontamination cell (308), and miscellaneous decontamination area equipment. The system is capable of handling approximately 4000 scfm of ventilation exhaust airflow. This airflow is filtered through a prefilter and two stages of HEPA filters and is exhausted to the atmosphere via the calciner area exhaust plenums and the NWCF stack. Major components of the cell are listed in Table 2-21.

The ventilation air cleanup cell functions include the following: (1) providing the proper environment for the operation of the equipment contained in the cell, (2) providing adequate radiation shielding of the cell components, (3) preventing the spread of contamination out of the cell, (4) isolating cell noise within the cell, and (5) permitting easy decontamination of the cell surfaces.

Table 2-21. Ventilation air cleanup system cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCD-126	Holding tank	304L ss	30 in. in dia x 60 in. long	20 gal	Stainless steel tank, vertical, ASME design for 30 psig, equipped with two 2 in. nozzles and one ¾ in. nozzle on top and two 1 ½ in. nozzles on the bottom. Liquid level control and pH monitoring.
P-NCD-226	Air scrubber recirculating pump	ss	---	25 gpm	Single suction, 150 ft, total head, stainless steel impeller housing, 3 hp, 3500 rpm.
ASA-NCD-929	Air scrubber cabinet	ss	3 ft wide x 4 ft 2 in. high x 5 ft 6 in. deep	4000 scfm	Complete with plastic packing, spray and flooding nozzles for 4000 scfm air, 2 in. drain connection on bottom of cabinet. Also includes any integral mist eliminator of the impingement type.
BLO-NCD-289	Scrubber system exhaust blower	304L ss	---	6440 cfm	Centrifugal multiple V-belt driven by constant-speed motor. Airfoil blade configuration, 10 hp motor, 1800 rpm.

Overhead shielding, provided by the cell ceiling and hatches, reduces radiation exposure rates to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure. Exterior shielding, provided by the concrete cell walls, limits radiation exposure rates to 0.125 mR/h at a distance of 1 ft from the cold face of a shielding structure.

A header and spray system is provided for internal cell and equipment decontamination. A floor drain and grating are provided to the nonfluoride hot sump tank (VES-NCC-122) for handling these decontamination solutions.

Confinement features of the cell and ventilation system prevent any postulated equipment failure from resulting in an uncontrolled release of airborne or liquid radioactivity.

2.4.3.2.9 Gas and Liquid Sampling Cell (320)—The gas and liquid sampling cell provides remote sampling capabilities, isolation and shielding for the gas and liquid sampling stations, and a receiving, transfer, and shipping point for the solids samples collected in the flowmeter cubicle (314).

The 4.5 x 25 ft cell has a concrete floor covered by a stainless steel deck with a 3 ft wainscot. Two shielded viewing windows and two sets of master-slave manipulators are provided to facilitate remote operations. A floor drain is provided to route solutions to the hot sump tank cell. Overhead decontamination sprays are provided to decontaminate the cell and its equipment. Decontamination lines are provided for also decontaminating the internal surfaces of the gas and liquid samplers. Entrance to the sample cell is gained through two doorways in entryway 325 on the second level. Overhead ceiling hatches are provided for equipment removal.

Liquid sampling stations were installed to sample the contents of the following vessels:

1. Calciner (VES-NCC-105)

2. Blend and hold tanks (VES-NCC-101, -102, and -103)

3. Scrub solution hold tank (VES-NCC-108)

4. Fluoride hot sump tank (VES-NCC-119)

5. Nonfluoride hot sump tank (VES-NCC-122)

6. Decontamination area holdup tank (VES-NCD-123)

7. Decontamination solution collection tank (VES-NCD-129)

8. Mist eliminator (VES-NCC-110).

Also installed in this cell are the pressure relief valves (PSV-112, -113, and -114-1) for the ruthenium adsorbers. The outlets of the valves are connected to the VOG line (6”-VGAD-2021).

The gas and liquid sample cell functions include the following: (1) permitting safe and remotely operated sampling of various vessels in the process system, (2) containing any activity released during sampling, (3) providing adequate shielding for those involved in sampling operations, (4) permitting easy decontamination of cell surfaces, and (5) providing a confinement area shielded from the adsorber cell to house the pressure relief valves for the POG cleanup equipment.

The shielding material in the viewing windows and cell walls reduces the radiation fields in the surrounding occupied areas to 0.125 mR/h. These walls are made of high-density concrete (220 lb/ft^3) to a height of 8 ft.

The remote sampling, maintenance, and decontamination capabilities significantly reduce radiation exposure to plant personnel and improve operating efficiencies. The negative cell pressure minimizes the possibility of exposing plant personnel to airborne contaminants if sampling spills occur inside the cell. Air from this cell is exhausted to the atmosphere via the calciner area exhaust system and the NWCF stack. Remote decontamination capabilities also reduce exposures to plant personnel if direct maintenance is needed inside the sampling cell.

2.4.3.2.10 Equipment Decontamination Storage Area (306)—The equipment decontamination storage area provides a dedicated storage area for items that are awaiting decontamination in the remote decontamination cell or have been decontaminated to the greatest extent possible and still need shielding while they are awaiting shipment.

The equipment decontamination storage area has approximately 300 ft^2 of concrete floor that is covered by stainless steel with a 6 in. wainscot. A floor drain is provided to route spills and decontamination solution to the NWCF hot sump tank. The area walls are coated with epoxy type paint. Access to this area is gained through the ceiling hatches or through a labyrinth-type entry on the second level. The decontamination area 30 ton overhead crane (CRN-NCD-901) serves this area.

The equipment decontamination storage area functions include the following: (1) providing a dedicated area for the storage of items awaiting decontamination, (2) preventing the spread of any contamination released in the area, (3) providing adequate radiation shielding for objects stored in the area, and (4) permitting easy decontamination of the area.

Shielding for radiation sources stored in the area provides adequate worker protection. A source placed at the center of the area with a radiation field as high as 50 R/h at 1 ft from the source ($E\gamma \sim$ 1.25 MeV) would result in a radiation field of 0.125 mR/h at 1 ft from the cold shielding surface. If this same source were placed 1 ft away from the hot surface of the shield, a radiation field of 0.5 mR/h at 1 ft from the cold surface of the shield would occur. The labyrinth-type entryway prevents direct radiation from streaming to the adjacent corridor. Furthermore, the doorway to this cell can be locked to prevent personnel from inadvertently entering a high-radiation zone.

A stainless steel floor in this area facilitates decontamination efforts and, therefore, when direct (hands-on) decontamination efforts are required, helps to minimize exposures to plant personnel.

Inlet ventilation air is admitted to the area via inleakage. A constant negative pressure in the area is maintained by the calciner area exhaust system.

2.4.3.2.11 Flowmeter Cubicle (314)—The flowmeter cubicle contains the four calciner vessel feedlines, their associated flow control valves and flowmeters, and the solids sampler.

The flowmeter cubicle isolates the equipment from other process cells and provides remote maintenance capabilities to increase on-stream efficiencies.

The flowmeter cubicle encloses a 9 x 12 ft area. The floor and west wall are covered with stainless steel; the remaining walls are covered with stainless steel to a height of 3 ft. The east wall is constructed of high-density concrete to a height of about 6 ft. The walls, floor, viewing window, and ceiling reduce the radiation fields in the surrounding occupied areas to 0.125 mR/h at a distance of 1 ft from the cold shielding surface. The entry to the cell has a 4 in. lead (steel clad) shielding door. Equipment is removed through the shielded ceiling hatch or through the corridor to the valve cubicle area via the overhead monorail (HST-NCD-941) and transfer area (326). A shielding window and master-slave manipulators are provided for remote maintenance functions. Tools are introduced via the tool port, which is located on the north side of the viewing window. A solid sampler (SAM-NCC-650) also is located in this area to provide remote sampling for the calciner vessel and remote return of the solids to the calciner vessel. A floor drain is provided to direct solutions to the hot sump tank cell. Personnel entrance to this cubicle is gained through a shielded entryway (313) on the second level. This entryway is stainless-steel-lined to facilitate decontamination operations. In addition, several transmitters (FT332-1, FT332-2, PT332-1, and PT332-2) are located in this entryway to prevent their contamination. Major components of the cubicle are listed in Table 2-22.

The flowmeter cubicle functions include the following: (1) providing adequate radiation shielding; (2) containing contamination; (3) permitting remote replacement, removal, and maintenance of the flow control valves and flowmeters in the calciner feed system; (4) permitting easy decontamination of cell surfaces; and (5) permitting remote sampling and solids characterization of the calcine and pneumatic transfer of the sample to the gas and liquid sample cell.

The remote capabilities for sampling and maintenance minimize radiation exposures to plant personnel as well as improve plant efficiency. Solids samples are conveyed pneumatically to the gas and liquid sample cell.

Failed equipment is moved into the remote decontamination cell (308) via the transfer area (326), the valve cubicle, the crane and maintenance transfer area (323), and the filter cell (216). Thus, removal of the failed component and its transfer to the remote decontamination cell are accomplished remotely. Decontamination lines are permanently attached to each feedline to aid in clearing a plugged line or feed nozzle or to help decontaminate the internal equipment surfaces if direct hands-on maintenance is required. Overhead cubicle sprays also are provided to aid in decontaminating the external equipment surfaces and the cubicle. Solutions from these sprays drain to the fluoride hot sump tank (VES-NCC-119). Air from this cell is exhausted to the atmosphere via the calciner area exhaust system.

2.4.3.2.12 Utility Room (324) and Utility Corridor (325)—The utility room and utility corridor are located to the south of the second-level operating corridor (318). The main entry point for all NWCF utilities (except for oxygen and kerosene) into the NWCF is through the utility corridor. The utility room contains the main shutoff and control valves, and the instruments associated with the utilities.

Table 2-22. Flowmeter cubicle components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
LGW-NCO-909	Shielding window	Lead glass	22 x 34 in.	---	Installed in 3 ft thick high-density concrete wall.
SME-NCC-905	Sample capsule capper/decapper	ss	---	---	Caps and decaps the bottles containing the solids sample.
MAN-NCO-915-1, -2	Master-slave manipulator	ss	---	50 lb	
---	Sample and capping rack	ss	---	---	Holds sample for capping.
TP-NCA-956	Tool port	ss	6 in. ID	---	Tool ports extend through the shielding wall near the shielding window.
---	Sample loader-receiver	ss	---	---	Transfers samples between sample cell and flowmeter cubicle.
---	Flowmeter and valve assembly	ss	---	---	Meters and controls flow of feed to calciner nozzles.
SAM-NCC-650	Sample station, solid (calciner)	ss	---	---	Sample station contains air jet cyclone, sliding gate mechanism, sample bottle, air-operated piston, ball valve and piping.

The waste organic solvent disposal piping enters the building through the utility corridor and is routed through the utility room and the second-level operating corridor to the calciner cell. The flow instrumentation for the solvent disposal line is located within a stainless steel enclosure in the utility corridor. Two block valves to isolate the instrument enclosure for instrument calibration or changeout also are located within the utility corridor.

The utility room and utility corridor functions include the following: (1) providing a centralized entry point for utilities, (2) protecting the flow of utilities into the NWCF against interruption because of natural phenomena, and (3) providing an easily accessible area to inspect and repair utility services.

A floor drain is provided to direct leakage in the room to the nonfluoride sump tank (VES-NCC-122). Fire protection is provided by an overhead wet-pipe system of spray heads. None of the utilities that enter the utility corridor is radioactive, but the waste solvent disposal piping contains organic solvent contaminated with low levels of fission products and alpha emitters. Because the amount of direct radiation from the solvent disposal line is so low, no shielding is provided for the line.

2.4.3.2.13 Personnel Decontamination Room (319)—The personal decontamination room serves as a control point in preventing the spread of contamination by personnel. Before leaving the second level, if contamination is detected, a cleanup area complete with a sink is provided for decontamination and telephones are provided for obtaining RCT assistance.

A self-monitoring station, decontamination supplies, a decontamination sink, clothing bins, and a communication system are the major components of the room.

The room is equipped with a sink that drains to the nonfluoride hot sump tank (VES-NCC-122). Ventilation is provided by the calciner area H&V system. The H&V system helps contain any contamination that is brought into the room. Fire protection is provided by an overhead wet-pipe sprinkler head system.

2.4.3.2.14 CAM Blower Room (327)—This room houses the CAM vacuum blowers (BLO-NCO-250-1 and -2). These blowers provide the vacuum force for the majority of the CAMs. Some CAMs are provided with vacuum pumps and are not connected to the central vacuum system. The main components of this room are the blowers.

The CAM blower room functions include the following: (1) providing the proper environment (temperature, etc.) for operation of the blowers, (2) providing containment of noise and of radioactive contamination that is released from the blowers and associated piping, and (3) protecting the blowers against damage from natural phenomena.

Ventilation is provided to the room by the calciner area H&V system. This system maintains the pressure differentials so that any released contamination is contained in the room.

The room is designed to withstand the DBE. Fire protection is provided by a wet-pipe overhead sprinkler head system. Because no floor drain is provided in this room, fire extinguishing water must flow to the drain either in the corridor (311) or the storage area (312).

2.4.3.2.15 Crane Maintenance Area (323)—The crane maintenance area provides an area in which the valve cubicle bridge crane and the filter handling and remote decontamination cell crane may be maintained by hands-on techniques.

The area also serves as the transfer point in passing items to the filter handling cell or the remote decontamination cell. A contaminated item is moved into the area by a valve cubicle crane, set down, and then picked up by the other crane.

This area contains no components per se. As described above, it is primarily a work station and transfer area.

The area is provided with a shielding window (LGW-NCO-980) to provide the necessary viewing for filter or equipment transfers.

The crane maintenance area functions include the following: (1) providing a shielded area in which maintenance of the two cranes may be performed, (2) preventing the spread of contamination resulting from maintenance of the cranes and the movement of filters, and (3) providing an area for transferring contaminated items from the valve cubicle and filter cell to the filter handling or remote decontamination cell.

The shielding window makes it possible to observe filter transfers to the filter handling cell. Without the window it would not be possible to make the necessary crane connections. The window provides shielding that is equivalent to the walls, 0.125 mR/h at 1 ft from the cold side of the window.

Ventilation of the area is provided by the calciner area H&V system. The system is designed to prevent the migration of activity from the area.

Access to this area for maintenance purposes is gained from a ladder located on the south wall of the manipulator maintenance and parking area (218). When personnel are in the area, they are shielded from the valve cubicle by shielding door 323A, from the filter handling cell by doors 309A and B, and from the POG line by a 4 in. lead brick wall.

2.4.3.2.16 Miscellaneous Second-Level Support Areas—Additional auxiliary and support components and areas on the second level include the following:

1. Upper portion of the process cells and valve cubicles

2. Instrument transmitters (cabinets, etc.)

3. Storage area (312)

4. Freight elevator (ELV-NCM-917)

5. Upper portion of hot sump tank removal and access cell (205)

6. Corridors 303, 311, and 318

7. Transport air heater (HE-NCO-318) located in the second-level corridor

8. Motive air heaters (HTR-NCO-307-1 and -2) located in the second-level corridor.

When possible, instrument transmitters have been located above the liquid levels in the tanks served. The transmitters are located outside the cells in the operating corridors. For the systems that are pressurized, the transmitters are located in enclosed instrument cabinets or in cell entryways. Process sensing lines for level, density, and differential pressure penetrate the cell walls and are converted to electronic signals. Thus, all signals transmitted to the control room are electronic, which eliminates lines containing radioactive process solutions in the control room. Confinement of radioactive spills is achieved by the following:

1. Providing enclosed stainless steel transmitter cabinets that drain solutions through seal loops back to the process cell floor drain and vent the cabinet atmosphere to the calciner exhaust system.

2. Providing a block valve in each sensing line for isolation in case of a process incident.

3. Maintaining each process sensing line under a continuous purge that flows toward the high-contamination zone.

Most instrument transmitters are located in the second-level operating corridor.

A storage area (312) is provided for instrument maintenance items, tools, etc. Freight elevator service is provided for the second level as well as for all other levels.

Airlock-type passageways (i.e., two doorways in series with proper airflow patterns) are provided at all stairways and service openings to control the spread of contamination between different levels of the NWCF building.

A transport air heater is located in the access corridor on the second level to heat the transport air to the product transfer system and prevent condensation in the transport air line.

2.4.3.3 Third Level. The third level lies 31 ft belowgrade at a reference elevation of 4883 ft above sea level and provides access to all major process cells (the calciner cell, the blend and hold cell, the off-gas cell, and the adsorber cell). In addition, this level provides access to the hot sump tank removal cell, the valve cubicle, and the return jet cubicle. Freight elevator service and a personnel survey and decontamination area are provided. Contamination control passageways are provided at all stairways and service entrances to provide radiation and contamination control.

Because the major process cells extend through two levels (i.e., from the third level through the second level), the second level houses the upper portion of the cells (the calciner cell, the blend and hold cell, the off-gas cell, the adsorber cell, the hot sump tank removal cell, and the filter cell) but provides no direct access into them.

Shielding is provided between the process cells and the third-level operating corridor by concrete walls of sufficient thickness to reduce radiation levels to below 0.125 mR/h. Shielding is discussed in detail in Chapter 7 of this safety analysis. All walls are reinforced concrete and structural steel. The calciner cell, the off-gas cell, and the valve cubicle have shielding windows and are equipped with master-slave and electromechanical manipulators to facilitate remote removal, maintenance, and replacement of process equipment. All process cells are provided with cell lights.

2.4.3.3.1 Blend and Hold Cell (215)—The blend and hold cell contains the blend tank (VES-NCC-101), two hold tanks (VES-NCC-102 and -103), two feed tanks (VES-NCC-104 and -152), the HLLWE reboiler (HE-NCC-350), a HLLWE condenser (HE-NCC-351), the HLLWE flash column (VES-NCC-150), and associated piping. The floor contains a sump. Cell access is gained through a door (215) from the access corridor (212) on the third level or from ceiling hatches on the first level.

This area has approximately 750 ft^2 of floorspace, a 4 ft thick concrete floor with a stainless steel deck, and a 3 ft wainscot. All walls are reinforced concrete with an epoxy coating above the stainless steel wainscot. Hatches are provided for overhead access (equipment removal, replacement, and maintenance). No shielded viewing windows are provided for this cell; however, cell lights are provided as well as removable plugs in the hatches to lower TV cameras into the cell. Major components of the cell are listed in Table 2-23.

The blend and hold cell functions include the following: (1) providing adequate radiation shielding for occupied areas, (2) preventing the spread of any contamination released inside the cell, (3) providing the proper environment (temperature, elevations, and pressure) for operation of the equipment, and (4) permitting easy decontamination by remote and direct techniques of cell surfaces and vessels.

Overhead shielding is provided by the concrete ceiling hatches that limit the radiation exposure dose rate to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure. Between-cell shielding is provided by the structural walls.

Radioactive liquid waste solutions transferred from the Tank Farm are temporarily stored and adjusted (feed complexing, blending, etc.) before transfer to the constant-head feed tank by airlift. Primary confinement of radioactive process solutions in the blend and hold cell is provided by the process equipment (vessels, piping, etc.) with secondary confinement provided by the process cell and the H&V system.

Electronic instruments associated with the blend and hold tanks are on standby power to ensure availability during loss of normal power. All associated pneumatic valving and valve systems were designed to fail-safe upon loss of the electronic signal or compressed air to the operators.

Check valves and remote control block valves are located in the following lines to prevent the backflow of radioactive liquid waste to other tanks, process areas, or the Tank Farm during postulated flooding conditions:

1. Tank Farm liquid waste transfer header (3"-PSAB-1700)

2. Recycle line (3"-PSAB-1911) from the scrub hold tank (VES-NCC-108)

3. Recycle lines (2"-PSAB-2754 and -2755) from the hot sump tanks (VES-NCC-119 and VES-NCC-122)

4. Airlift air supply lines (3/4"-LSAB-3688, -3689, and -3694)

5. Jet lines and overflow lines to the hot sump tank from the blend and hold tanks

6. Overflow line (1-1/2"-PSAB-1722) from the feed tank to the hold tanks.

Table 2-23. Blend and hold cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCC-101	Blend tank	Nitronic 50	108 in. T-T, 114 in. in dia	5870 gal	Designed for 30 psig. Internal heating-cooling coil, airstream sparge ring, decontamination spray head, 7/16 in. shell thickness. Operating temp is 122°F (0.125 in. corrosion allowance). Design temperature is 300°F.
VES-NCC-102, -103	Hold tanks	Nitronic 50	108 in. T-T, 96 in. in dia	4000 gal	Same as above.
VES-NCC-104	Feed tank	Nitronic 50	42 in. T-T, 24 in. in dia	103 gal	Designed for 120 psig internal pressure, 7.4 psi external pressure, provided with decontamination spray head. 5/16 in. shell thickness (0.125 in. corrosion allowance). Design temperature is 300°F. There are spargers in the bottom of the vessel.
VES-NCC-150	Flash column	Hastelloy G-30	154 in. T-T, 64 in. in dia	2600 gal	Designed for 100 psig at 300°F. 7/16 in. shell thickness.
VES-NCC-152	Evaporator feed tank	Nitronic 50	96 in. T-T, 24 in. in dia	200 gal	Designed for 100 psig at 300°F. Overflows back to the blend tank (VES-NCC-101).
HE-NCC-350	Evaporator reboiler	Hastelloy G-30	13 x 144 in.	110 gal	Shell designed for 150 psig at 400°F and tube designed for 100 psig at 400°F. Contains 145 ¾ in. x 12 ft tubes.
HE-NCC-351	Evaporator condenser	Hastelloy G-30	13 x 96 in.	25 gal	Shell designed for 100 psig at 125°F and tube designed for 100 psig at 260°F. Contains 48 ¾ in. x 8 ft tubes.
JET-NCC-501-1	Blend tank drain jet	304L ss	1-1/2 in.	25 gpm	Steam jet syphon.
JET-NCC-501-2	Blend tank decontamination solution recirculation jet	Same as above	1 in.	40 gpm	Same as above.
JET-NCC-502-2, -503-2	Hold tanks drains and decontamination solution recirculation jets	Same as above	Same as JET-NCC-501-1	40 gpm	Same as above.
JET-NCC-504	Feed tank drain jet	Nitronic 50	1 in.	10 gpm	Steam jet syphon.
JET-NCC-507	Evaporator transfer jet	Hastelloy G-30	2 in.	25 gpm	Steam jet syphon.
JET-NCC-502-1, -503-1	Hold tank drain jet	304L ss	1-1/2 in.	25 gpm	Steam jet syphon.

7. Addition lines (3”-CNAF-2550 and -2551) from the solution tank and the calcium nitrate hopper

8. Decontamination lines.

Pressure- and temperature-indicating and alarm instruments aid operating personnel in controlling operating parameters associated with blend and hold cell equipment.

All vessels vent to the equipment vent condenser (HE-NCC-336) and the vent condenser KO drum (VES-NCC-136), which drain to the scrub hold tank. The equipment vent system connects to the NWCF off-gas header between the ruthenium adsorbers (VES-NCC-112, -113, and -114) and the mist eliminator (VES-NCC-116) to facilitate filtration of the VOG. During normal operation, the blend, hold, and feed tanks are under 8 to 12 in. of W.C. vacuum.

Detection of possible breach of primary confinement is facilitated by a CAM system consisting of a wall-mounted CAM located outside the blend and hold cell, drawing air from the cell. The cell air is drawn into the CAM, is filtered, flows through the CAM vacuum system, and is exhausted into the calciner area H&V system after passing through the CAM blower.

A liquid collection sump and drain are provided for detecting liquid leakage in the blend and hold cell. During normal operation, the manual block valve on the drainline to the fluoride hot sump tank is in the closed position, and the floor sump, equipped with an alarm (UA-005-20), collects any liquid leaking within or into the cell. The cell floor drainline is provided with a bubbler probe leak detection system.

Blend and hold cell overhead hatches are sized to facilitate blend, hold, evaporator, and feed tank removal for replacement or decommissioning activities. A 30 ton bridge crane with a 5 ton auxiliary hoist and a PaR Model 3000 bridge-mounted mechanical manipulator are provided for remote equipment removal and maintenance.

Internal decontamination of the blend, hold, and feed tanks is facilitated by decontamination spray heads or by simply adding solution to a tank in the same manner as waste feed. After being added to a tank, the solution is heated, recirculated, and agitated via air or steam sparge. Recirculating decontamination solutions minimizes the quantity of waste generated. To decontaminate the feed tank and associated piping, solution is airlifted to the feed tank and then gravity-fed to the calciner in the normal manner. Cell sprays are provided for external decontamination of equipment.

Confinement features of the process cell and ventilation system prevent any postulated equipment failure from resulting in a significant release of radioactivity to the occupied areas of the plant or to the environment.

2.4.3.3.2 Calciner Cell (214)—The calciner cell (214) contains the calciner vessel and the cyclone, and the associated piping (off-gas piping and solids transport piping, etc.). The interior of the cell can be observed through shielding windows from the access corridor (third level).

This area has approximately 650 ft^2 of floorspace, a 4 ft thick concrete floor with a stainless steel deck, and a 3 ft stainless steel wainscot. All walls are reinforced concrete with an epoxy coating above the wainscot. Cell access is gained through a door (214) via entry 213 or from ceiling hatches.

Remote maintenance and equipment removal are facilitated from the maintenance area by the cell hatches, a 30 ton bridge crane, and a PaR Model 3000 bridge-mounted mechanical manipulator. The cell also is equipped with two pairs of master-slave manipulators. Two shielded viewing windows and two plugs for the future addition of two other windows are provided. Major components of the cell are listed in Table 2-24.

Primary containment of radioactive solutions and solids is provided by the process equipment and associated piping with secondary containment provided by the process cell and ventilation system. Type 347 stainless steel is used for the vessels and piping in this cell for its corrosion resistance at the elevated process temperatures (400° to 600°C [752° to 1112°F]). The thickness of vessels and pipe walls was established conservatively to be able to withstand 20 years of typical process corrosion. Areas of high erosion such as bends and elbows in the product transfer line are made of blinded tees and wear pads. A blinded tee collects calcine in the corner of the tee, which acts as a buffer between the flowing calcine and the product transfer line piping.

The calciner vessel and cyclone were originally designed to operate at a maximum temperature of 600°C (1112°F) with a nominal operating bed temperature of 500°C (932°F).[23] The calciner vessel and cyclone were constructed of Type 347 stainless steel for its resistance to carbonization at operating temperatures up to 600°C (1112°F). Engineering evaluations[24,25] have concluded that the calciner vessel and cyclone have sufficient structural integrity to meet the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, requirements at a maximum design and operating temperature of 700°C (1292°F). Increasing the calciner bed nominal operating temperature form 500°C (932°F) to up to 600°C (1112°F) allows the option of increasing the calcination rate of the sodium bearing waste.

Components of the off-gas scrubbing system, including piping, that are exposed to the scrubbing solution were constructed of Armco Nitronic 50 stainless steel. This material has excellent resistance to hot 75°C, 4 M nitric acid solutions containing fluoride ions. The feed, hold, blend, and hot sump tanks and associated piping were constructed of Nitronic 50 stainless steel. Vessels were designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

Electronic instruments associated with the calciner cell are on standby power to ensure availability during loss of normal electrical power service. All associated pneumatic valving and valve systems are designed to fail-safe on loss of electronic signal or compressed air to the operator. Standby electrical power is provided to perform an orderly shutdown of the entire calcination process and to maintain it in a shutdown condition until normal power is restored to the NWCF.

Pressure-, temperature-, and flow-rate-indicating and alarm instruments aid operating personnel in controlling operating parameters associated with the calciner cell equipment.

A liquid collection sump and floor drain are provided for detection of liquid leakage in the calciner cell. The floor is sloped to the gutter and away from the door. The gutter is then sloped toward the sump. The floor sump collects any liquid leaking within the cell and sounds an alarm at a predetermined setpoint.

Shielding is provided by the cell's concrete ceiling, hatches, and walls, which limit the radiation exposure rate to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure.

Table 2-24. Calciner cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCC-105	Calciner	Type 347 ss	5 ft increasing to 7 ft in dia x 21 ft 9 in. long (overall)	---	Evaluated to allow operation at 11 psig; 700°C (1292°F) maximum operating temperature; one sparge ring; four waste feed nozzles, four fuel nozzles; ¾ in. conical bottom thickness; distributor plate; Type 347 ss; baffle assembly 10 ft and 7 ft straight sections. The fluidized bed section is covered with 1-1/2 in. of high temperature insulation, with 4 in. on the remainder of the vessel, and sealed.
VES-NCC-107	Cyclone	Type 347 ss	24 in. in dia x 8 ft	1500 scfm	Evaluated to allow operation at 13.8 psig; maximum pressure drop 12 in. of water; 700°C (1292°F) maximum operating temperature; decontamination sprays; ¼ in. wall thickness; 0.125 in. corrosion and erosion allowance. Covered with 3 in. of high-temperature insulation and a sealed Type 304L ss shroud.
SP-1040	Fluidizing pad	Type 316 ss	---	---	Sintered-metal screen.
SP-1035	Product removal system	Nitronic 50	1.3 in. ID	---	
MAN-NCA-916-1, -2, MAN-NCA-917-1, -2	Master-slave manipulators	300 series ss	---	50 lb	Used to perform remote maintenance in cell (i.e., nozzle changeout). Capable of motion in x, y, and z directions.
LGW-NCA-912-1, -2	Shielded viewing windows	Lead glass	Varies from window to window	---	Shielded viewing windows on N and S sides of calcine cell. Maximum viewing angle.
LGW-NCA-921-1, -2	---	---	---	---	Spaces for lead shielding window.

Internal decontamination of the calciner vessel is facilitated by decontamination lines connected to a sparge ring located in the bottom of the vessel and spray nozzles in the top of the vessel. A separate sparge ring supplied with air and steam is provided above the distributor plate for sparging and heating the decontamination solutions. Cell sprays are provided for external decontamination of equipment.

2.4.3.3.3 Off-Gas Cell (207)—The off-gas cell (207) contains the scrub solution hold tank (VES-NCC-108), the scrubbing solution cooler (HE-NCC-332), the quench tower (VES-NCC-109), the venturi scrubber (VES-NCC-511), the venturi scrubber KO drum (VES-NCC-111), scrubbing solution pumps (P-208-1 and -2), the condenser (HE-NCC-333), and the mist eliminator (VES-NCC-110).

The cell has approximately 550 ft^2 of floorspace, a 4 ft thick concrete floor with a stainless steel deck, and a 3 ft wainscot. All walls are reinforced concrete with an epoxy coating above the wainscot. Cell access for personnel is gained from a door (207) on the access level (third level) and through the ceiling hatches for large equipment items. One shielded viewing window, an associated pair of master-slave manipulators, and a tool port are provided on the third level for remote removal and replacement of scrub pumps. The cell floor is sloped away from the cell entry and toward the gutter. The gutter slopes toward the sump. Major components are listed in Table 2-25.

Calciner off-gas is passed through the quench-scrub section of the off-gas cleanup train before reaching the ruthenium adsorber cell. The quench system functions including the following: (1) cooling the off-gas ranging from 500° to 600°C (932° to 1112°F) to lower than 70°C (158°F) and (2) removing the majority of the larger fines particulate.

Ventilation air is drawn from the access corridor at a rate of about 2890 cfm and is exhausted to the calciner area exhaust air duct system. Pressure differentials and airflow patterns within the NWCF ensure airflow from areas of lesser contamination potential to areas of greater contamination potential. This technique minimizes the spread of contamination, which might be created internally or in another process area.

Overhead shielding is provided by the cell's concrete ceiling and hatches, which limit the radiation exposure rate to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding walls.

Except for the pumps and valves, all major components of the off-gas scrubbing system that are exposed to the scrubbing solution are constructed of Armco Nitronic 50 stainless steel for resistance to the hot (75°C [167°F]) 4 M nitric acid solution containing fluoride ions.

Check valves and block valves are located in the following lines to prevent the backflow of contaminated scrub solution to other tanks, vessels, or process areas: (1) the nitric acid supply line (1/2"-NAAF-2259) from the decontamination nitric acid tank (VES-NCC-118), (2) the decontamination solution supply line (PL-119-2) from the decontamination solution tank (VES-NCC-117), (3) the steam supply line (3"-PLAD-4226) to the scrub hold tank heating coil, and (4) the recycle line (1-1/2"-PSAB 1917) to waste hold tanks.

Operations personnel use pressure-, temperature-, level-, and flow-rate-indicating and alarm instruments in controlling operating parameters associated with the off-gas equipment.

Table 2-25. Off-gas cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
HE-NCC-332	Scrub solution cooler	Type 304L ss	Vertical 15 in. dia shell, 12 ft tubes	1,480,000 Btu/h	Shell and tube heat exchanger using cooling water at 60°F to cool 100 gpm nitric acid from 135°F to 104°F. Designed for 150 psig in accordance with ASME Code requirements; six-tube pass.
HE-NCC-333	Off-gas condenser	Type 304L ss	26 in. dia shell, 12 ft tube length, 1800 ft^2 surface for cooling	1,460,000 Btu/h	Shell and tube condenser; 15°C cooling water in shell.
VES-NCC-108	Scrub solution hold tank	Nitronic 50	60-in. ID x 144 in. T-T	2000 gal	Designed for 15 in. Hg vacuum and 30 psig at 135°C, internal steam heating coil, steam air sparger, and decontamination sprays. 0.125-in. corrosion allowance. Two 24 in. manholes for mounting pumps. 7/16 in. wall.
VES-NCC-109	Quench tower	Nitronic 50	42 in. ID x 12 ft T-T	1350 scfm at 10.3 psia	Designed for 15 in. Hg vacuum and 30 psig. Maximum pressure drop 3 in. of W.C.; internal spray nozzles; decontamination ring; inlet gas temp 450°C, outlet gas temp 75°C, inlet liquid temp 40°C, and outlet liquid temp 65°C. Corrosion allowance: 0.125 in. Wall: ¾ in.
JET-NCC-508	Scrub hold tank drain	Type 304L ss	1 ½ in.	---	Steam jet syphon.
P-NCC-208-1, -2	Scrub solution recycle pumps	Type 304L ss or Nitronic 50 in contact with fluid	---	140 gpm at 150 ft TDH	Vertical centrifugal, mounted on 24 in. flange. Flange and pump motor to be assembled complete with retained nuts, guide rods, and lifting bail for remote removal and replacement.
VES-NCC-110	Mist eliminator	Nitronic 50	36 in ID x 9 ft 4 in. T-T	1325 scfm	Two-stage mist eliminator; two stages of progressively finer mesh. Designed for 15 in. Hg and 30 psig; inlet gas pressure: 7.6 psia; maximum Δ P: 8 in. of W.C.; design temp: 121°C; irrigating nozzles spraying on the upstream face of each element. Three pressure taps to measure drop across elements. Wall: ¾ in.
VES-NCC-111	Venturi scrubber KO drum	Nitronic 50	30 in. OD, 11 ft x 2 ½ in. overall length	---	Design pressure 30 psig; design temperature 350°F. Shell is ¾ in. thick; cones are 3/8 in. thick. Corrosion allowance of 0.125 in. Equipped with decontamination sprays.
VES-NCC-511	Venturi scrubber	Nitronic 50	Approx. 45 in. long	1587 scfm	Design pressure is 30 psig and 7.5 psig vacuum. Design temperature is 350°F.
MAN-NCA-918-1, -2	Master-slave manipulators	300 series ss	---	50 lb	Used to perform remote maintenance in the cell. Capable of motion in X, Y, and Z directions.

Table 2-25. (continued).

Equipment Number	Name	Material	Dimensions	Capacity	Notes
TP-NCA-956-4	Tool port	ss	6 in. in dia	---	Used to introduce tools, etc., into the cell.
LGW-NCA-913	Shielded viewing window	Lead glass	Varies	---	Shielded viewing window on off-gas cell. Maximum viewing angle.

A liquid collection sump and drain are provided for the detection of liquid leakage in the off-gas cell. The cell floor drainline is provided with a bubbler probe leak detection system.

Off-gas cell hatches are sized to facilitate equipment removal for maintenance or decommissioning activities. A bridge crane (CRN-NCM-901) with an auxiliary 5 ton hoist, a PaR Model 3000 manipulator, a set of master-slave manipulators, and a shielding window are provided for remote equipment removal and maintenance.

Internal decontamination of the off-gas cell equipment is facilitated by decontamination sparge rings or by simply adding solution to the scrub hold tank. After being added to the scrub hold tank, the solution is heated and recirculated through the scrubbing system in the normal manner. Cell sprays are provided for external equipment decontamination.

2.4.3.3.4 Adsorber Cell (206)—The adsorber cell (206) contains an off-gas superheater (HE-NCC-334) and a reheater (HE-NCC-335), three ruthenium adsorbers (VES-NCC-112, -113, and -114), an equipment vent condenser (HE-NCC-336), a vent condenser KO drum (VES-NCC-136), and a mist collector (VES-NCC-116). Calciner off-gas passes through this section of the off-gas cleanup train after leaving the scrub-quench section and before entering the filter cell (216), which contains the HEPA-grade prefilters and final double HEPA filters. The adsorber cell cleanup equipment functions include the following: (1) removing volatile ruthenium and (2) removing moisture entrained in the off-gas to prevent deposition on the final HEPA filter. Additional particulate removal is provided by the adsorbers and the mist eliminator. VOG from the blend and hold tanks, hot sump tanks, and the decontamination area equipment is routed to the equipment vent condenser to remove moisture. VOG is discharged to the main NWCF off-gas header downstream from the adsorbers.

The adsorber cell has approximately 800 ft^2 of floorspace, a 4 ft thick concrete floor with a stainless steel deck, and a 3 ft wainscot. All walls are reinforced concrete with an epoxy coating above the wainscot. Cell access is gained from a labyrinth-type entry through a lead-shielded door (206) on the third level or through the ceiling hatches. Major component of the cell are listed in Table 2-26.

The adsorber cell functions include the following: (1) confining any activity released into the cell, (2) providing the required environment for the adsorbers, and (3) providing the necessary radiation shielding to protect personnel.

Overhead shielding is provided by the cell's concrete ceiling and hatches, which limit the maximum radiation exposure rate to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure. Exterior shielding is provided by the cell's concrete walls, which reduce the maximum radiation exposure rate to 0.125 mR/h at 1 ft from the cold surface of the shield. The cell floor slopes from the entryway to the gutter. The gutter slopes to a drain that routes solution to the nonfluoride hot sump tank.

The off-gas cleanup system provides the primary containment of radioactive POG. The process cell provides secondary containment.

Adsorber cell overhead hatches are sized to facilitate removal of the adsorber, mist eliminator, superheater, etc., for maintenance or decommissioning activities. A 30 ton bridge crane, with a 5 ton auxiliary hoist, is provided for equipment removal and maintenance. A PaR Model 3000 bridge mounted mechanical manipulator also is available for remote maintenance work.

Table 2-26. Adsorber cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCC- 112, -113, -114	Ruthenium adsorber	Type 304L ss	96 in. in dia x 21 ft long (overall)	640 scfm	Designed for 7.5 psig vacuum and 30 psig at 250°F; internal support grid for 17,000 lb of silica gel; internal steam heating coil; decontamination spray head; 0.0625 in. corrosion allowance. Bed is divided into two sections: a lower 2 ft deep section and a second section approximately 64 in. deep. Wall: 7/16 in. thick.
VES-NCC-116	Mist collector	Type 304L ss	42 in. ID x 6 ft 6 in. T-T	1825 scfm 6.7 psia and 75°C	A standard mist collector with roughing and high-efficiency elements. Designed for 15 in. Hg vacuum and 30 psig; element flush nozzles; decontamination nozzles; pressure taps; 0.0625 in. corrosion allowance. Wall: 11/16 in. thick.
HE-NCC-334	Adsorber superheater	Nitronic 50 tubes; Type 304L ss shell	20 in. in dia x 5 ft long	66,300 Btu/h	Vertically mounted shell-and-tube heat exchanger using steam at 30 psig to increase the temperature of 6138 lb/h of off-gas by 36°F. Designed for 50 psig at 300°F. One-tube pass.
HE-NCC-335	Process gas reheater	Type 304L ss	20 in. in dia x 5 ft long	88,600 Btu/h	Vertically mounted shell-and-tube heat exchanger using steam at 30 psig to raise the temperature of 8500 lb/h of off-gas from 65°C to 85°C. One-tube pass. Designed for 50 psig at 300°F. Process gas in tubes, steam in shell.
VES-NCC-136	Vent condenser knock-out drum	Type 304L ss	16 in. OD x 5 ft 6 in. T-T	---	Vertically mounted. Design pressure is 30 psig. 7.5 psig vacuum and design temperature is 250°F.

Internal decontamination of the adsorbers and mist eliminator is facilitated by decontamination sprays or by overflowing decontamination solution from the scrub section of the off-gas system. Cell sprays are provided for external decontamination of equipment.

2.4.3.3.5 Filter Cell (216)—The filter cell contains four parallel sets of off-gas filters. Each filter bank contains three stages in series with each stage consisting of two parallel filters. These filters constitute the final section of the NWCF off-gas cleanup system and provide the final particulate removal before NWCF off-gas is discharged to the APS via the off-gas blowers.

In addition, the filter cell provides remote filter removal, remote replacement, and aerosol-testing capabilities. Shielding windows, an electromechanical manipulator, and the overhead 1 ton crane in the valve cubicle are provided to facilitate the remote removal and replacement of the filters. The valve cubicle and filter cell are used for storage of spent NWCF filters until they can be processed through the filter-leach system.

The filter cell has approximately 300 ft^2 of floorspace. All walls are reinforced concrete with a stainless steel lining. The floor is about 4 ft thick reinforced concrete with a stainless steel deck and a liquid collection sump. Cell access is gained through the manipulator maintenance and parking area, through the valve cubicle, and through removable ceiling hatches. Two shielding windows and an electromechanical manipulator (wall-mounted) are provided for remote filter changeouts. Major components of the cell are listed in Table 2-27.

Pressure differentials ensure airflow from areas of lesser contamination potential to areas of greater contamination potential. Overhead shielding provided by the ceiling and hatches is adequate to limit the maximum radiation exposure rate to 0.125 mR/h at a distance of 1 ft from the cold face of the shielding structure. Exterior shielding is provided by the cell's concrete walls, which limit the maximum radiation exposure rate to < 1.25 mR/h at a distance of 1 ft from the cold face of a shielding wall except for the third-level corridor. The corridor has an exposure rate of < 0.125 mR/h. The off-gas cleanup system provides primary confinement of radioactive POG, and the process cell(s) provide secondary confinement.

The filter housing, frames, and off-gas piping are constructed of Type 304L stainless steel because of its corrosion resistance to acid-laden (i.e., HNO_3) off-gas to ensure the confinement integrity of this system. Electronic instruments associated with the filter cell are on standby power to ensure operation during loss of normal power.

Check valves or block valves are located in the following lines to prevent backflow of radioactive off-gas to other than designed areas: (1) aerosol smoke injection lines, (2) sample lines, and (3) decontamination lines.

Operations personnel use pressure-differential-, temperature-, and flow-rate-indicating and alarm instruments in controlling operating parameters associated with the off-gas filters.

A liquid collection sump and drain are provided for the detection of liquid leakage in the filter cell.

Detection of a breach in a prefilter or a final HEPA filter may be detected by loss of pressure differential across the filter in question.

Table 2-27. Filter cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
F-NCC-130-1, -2, -3, -4	Off-gas filter units	Type 304L ss	Roughing and HEPA filters 24 in. x 24 in. x 11 ½ in.	---	Off-gas filter housing complete with one roughing filter and two HEPA filters in series. Designed pressure range of -8.5 to 10 psig at 175°C. Filter built with stainless steel frames. Roughing filters - 95% efficiency; HEPA filters - 99.97% efficiency by aerosol test. Filter unit to be insulated and jacketed. Seismically qualified for DBE.
LGW-NCA-910-1, -2	Shielded viewing windows	Lead glass	Varies from window to window	---	Maximum viewing angle.
CRN-NCD-905	Electro-mechanical manipulator	Carbon steel	---	---	PaR Mod 3000. Manipulate filters during decontamination and packaging.

Filter cell hatches are sized to facilitate filter housing and associated equipment removal for maintenance or decommissioning activities. A 30 ton bridge crane with an auxiliary hoist and a PaR Model 3000 bridge-mounted mechanical manipulator are provided for remote equipment removal and maintenance in addition to the wall-mounted electromechanical manipulator used for filter changeouts.

Internal decontamination of the off-gas piping and filter housing is facilitated by adding decontamination solution directly to the off-gas header via decontamination solution lines after all filters have been removed from the housings. Cell sprays are provided for external decontamination of equipment.

2.4.3.3.6 Hot Sump Tank Cell (102)—The hot sump tank cell houses the two hot sump collection tanks and a recirculation pump. This is the lowest point in the NWCF (elevation 4,852.0 ft above sea level). All process cell floor drains and equipment drains are routed to one of the two collection tanks (VES-NCC-122 for nonfluoride collection and VES-NCC-119 for fluoride collection). A floor sump is provided in the hot sump tank cell, and solution from the sump is jetted to the fluoride hot sump tank (VES-NCC-119).

The hot sump tank cell has approximately 1000 ft^2 of floorspace. The cell contains the two hot sump tanks and an associated valve access room, which is separated from the tanks by a shielding wall. The floor and walls are lined with stainless steel. The floor has a sump that can be jetted to the fluoride hot sump tank. A hatch in the ceiling of the cell provides the only entrance to the cell for equipment removal. Personnel access to this cell is gained via a ceiling hatch and ladder in the valve access room (101). Major components of the cell are listed in Table 2-28.

Ventilation air is drawn at a rate of 2850 cfm from the hot sump tank removal and access cell and exhausts to the exhaust duct system located on the third level. Pressure differentials ensure airflow from areas with lesser contamination potential to areas with greater contamination potential. Thus, airborne contaminants will not escape to the occupied areas of the building.

Shielding is provided by a 3 ft thick concrete wall for the adjoining valve room and by concrete and steel cell hatches for the hot sump tank removal and access cell. This area is classified as a "limited-access area," and its design radiation field is 1.25 mR/h at a distance of 1 ft from the shielding structure.

Primary confinement of radioactive solutions is provided by the process equipment and associated piping. Secondary confinement is provided by the process cell and its filtered H&V system.

Both hot sump tanks are vented to the equipment vent system and are operated at a negative pressure (about 8 to 10 in. of W.C. vacuum) to ensure an influx of air from the cell should a leak develop in the vapor space of the tank. Provisions have been made to pump or jet the contents of either tank to (1) the other tank, (2) the PEW evaporator, (3) either the blend tank or the hold tank, or (4) the Tank Farm.

Table 2-28. Hot sump tank cell components.

Equipment Number	Name	Material	Dimensions	Capacity	Notes
VES-NCC-119	Fluoride hot sump tank	Nitronic 50	108 in. ID x 10 ft 6 in. T-T	6420 gal	Designed for 7.5 psig vacuum and 30 psig, design temperature: 194°F, internal heating-cooling coil, mixing sparger, decontamination spray heads, ½ in. wall thickness, and 0.125 in. corrosion allowance. Temperature, density, liquid-level, and sample probes.
VES-NCC-122	Nonfluoride hot sump tank	Nitronic 50	90 in. ID x 10 ft 6 in. T-T	4280 gal	Same as above.
P-NCC-219	Fluoride hot sump pump	Type 304L ss	---	53 gpm	Vertical, cylindrical, mounted on top of vessel. Flange and motor are assembled complete with remote disconnects, retained nuts, guide rods, and lifting bail for removal and replacement. Motor is installed so that it can be replaced remotely without disconnecting pump.
JET-NCC-519-1, -2	Fluoride sump tank jet drain	Type 304L ss	1-1/2 in.	20 gpm	Steam syphon jet.
JET-NCC-522-1, -2	Nonfluoride sump tank sample jet	Type 304L ss	1-1/2 in.	20 gpm	Air jet booster.
JET-NCC-551	Vault sump drain jet	Type 304L ss	1-1/2 in.	14 gpm	Steam syphon jet.

Electronic instruments associated with the hot sump tank cell are on standby power to ensure operation during loss of normal electrical power service. All associated pneumatic valves and valve systems are designed to fail-safe on loss of electronic signal or compressed air to the operator.

Check valves or manual block valves are located in the following lines to prevent the backflow of radioactive liquids to vessels other than designed vessels or to process areas during normal or abnormal operating conditions:

1. Decontamination solution addition (DC-122-2 and DC-119-2)

2. Floor drainlines

3. Sample lines

4. Steam and air supply lines to vessel spargers

5. Steam supply lines to jets.

Pressure-, density-, level-, and temperature-indicating and alarm instruments are provided to control operating parameters associated with hot sump tank cell equipment.

2.4.3.3.7 Valve Access Room (101)—The valve access room contains the valves associated with the hot sump tanks. The room provides protection from the radiation fields associated with those tanks and makes it possible to perform maintenance on the valves without very extensive decontamination of the tanks.

The valve access room is approximately 210 ft^2 in area. The main components are the valves associated with the hot sump tanks. A permanent catwalk is provided in the room to permit easy access and maintenance of the valves. The room is lined with stainless steel. Personnel access is gained by way of a hatch and ladder from the valve operating area directly above the valve access room. A 3 ft thick concrete wall separates the room from the hot sump tank cell.

The valve access room functions include the following: (1) separating the valves from the valve operating extensions, (2) providing personnel protection from the radiation fields associated with the hot sump tanks and the valves themselves, and (3) providing ventilation to prevent the spread of any contamination released into the room.

The hot sump tanks may be decontaminated, but to do so each time a valve has to be worked on would be difficult and time consuming. Therefore, the valves are placed in the valve access room with radiation protection from the hot sump tanks provided by a 3 ft thick concrete wall. Hands-on maintenance of a valve requires decontamination of the valve, its line, and the surrounding valves and lines, which is much easier than decontamination of the tanks.

During normal operations personnel do not enter the valve access room. Operation of the valves is achieved by reach rods from the valve operation area above. Radiation protection for the operating personnel is provided by a 2 ft thick ceiling.

The calciner area H&V system provides heating, ventilation, and air conditioning (HVAC) to the valve access room. Air enters the room from the hot sump tank removal cell and exits via the hot sump tank cell. Contamination is prevented from spreading to the hot sump tank removal cell by maintaining a pressure differential of 0.5 in. of W.C. between the two areas.

The room is provided with a gutter that drains to the hot sump tank cell sump. The sump is provided with a level alarm (LSH-551-1). Activation of the alarm indicates possible leakage in either the valve access room or the hot sump tank cell. The origin of a leak can be ascertained via a TV camera inserted in one of the openings in the steel hatch over the hot sump tank cell and the hatch opening leading to the valve access room.

2.4.3.3.8 Decontamination Collection Tank Cell (203)—The decontamination collection tank cell provides a shielded collection and recycle area for solutions from remote decontamination operations. Solutions from the remote decontamination cell (308), the decontamination cubicles (421 and 422), the filter handling cell (309), and the equipment decontamination room (418) can be routed to the decontamination solution collection tank (VES-NCD-129) and recycled to the remote decontamination cell or transferred to the Tank Farm.

This cell, which is about 145 ft^2, contains the decontamination collection tank and the recycle pump (P-NCD-229). Shielding walls that are 18 in. thick provide isolation for each item of equipment. The floor and lower 6 in. of the cell walls are lined with stainless steel. The walls have a protective epoxy coating above the stainless steel wainscot. Personnel access to the cell is gained from the third-level corridor via the lube oil console room.

Vessel access is gained through the blocked-in opening in the east wall. This wall adjoins the hot sump tank removal and access cell. A floor drain is provided to direct solution to one of the two hot sump tanks. The contents of the decontamination collection tank are sampled from the gas and liquid sampling cell.

Ventilation air is supplied and exhausted from this area at a rate of 300 cfm by a branch of the calciner area H&V system. Pressure differentials ensure airflow from areas with lesser contamination potential to areas with greater contamination potential.

The 18 in. interior shielding walls limit the maximum radiation exposure rate in the operating corridor to < 0.125 mR/h at a distance of 1 ft from the cold surface of a shielding wall. Breach of confinement within the cell does not result in the release of contaminants to the environment or to occupied areas of the building, because the HEPA-filtered H&V exhaust system and the cell provide adequate confinement of the contaminants.

The cell floor drainline is provided with a bubbler probe leak detection system.

2.4.3.3.9 Lube Oil Console Room (202)—The lube oil console room provides a shielded area where the lube oil for the POG blowers can be monitored for temperature, cooled, and filtered.

The lube oil console room, which is about 180 ft^2, contains the lube oil consoles for the off-gas blower. Each console includes a heat exchanger to cool the lube oil, a filter to remove particulate, and a pump to recycle the conditioned oil back to the pump or blower. The oil temperatures and recirculation pump discharge pressures are recorded from the third-level corridor.

Because the contamination and radiation levels in this area are expected to be very minimal, the structural 3 ft thick concrete walls provide adequate shielding for the third level corridor.

Access to this area is gained from the third-level corridor via a doorway in the south wall of the lube oil console room.

Ventilation air is supplied to this area at a rate of about 200 cfm and is exhausted at a slightly higher rate to prevent any cross-contamination of airborne contaminants to the third-level corridor. Radiation sources anticipated for this area do not impact any of the surrounding areas, because the structural wall thickness reduces the radiation level outside the room to < 0.125 mR/h above background at 1 ft from the cold side of the shield.

Penetrations through the corridor wall for instrument lines are sealed and installed to prevent radiation fields in the third-level corridor from exceeding 0.125 mR/h at a distance of 1 ft from the cold surface of the shielding wall. Should the cooler for one of the lube oil consoles fail, the oil is confined to the room by a floor sump. Should two consoles fail, the oil is confined to the room by a surrounding curb. Fire protection is provided by an overhead sprinkler system providing 0.25 gpm/ft 2 of floor area per sprinkler head.

2.4.3.3.10 Decontamination Holdup Tank Cell (219)—The decontamination holdup tank cell provides a collection point for decontamination solutions that are used in the decontamination area. These solutions can be filtered and recycled or sent to the hot sump tanks. Dedicating a vessel for this purpose allows the decontamination area to operate independently of the calciner area hot sump tanks.

The decontamination holdup tank cell contains the decontamination holdup tank (VES-NCD-123) in a 14 x 14 ft room. The floor and lower 6 in. of the walls are covered with stainless steel. The decontamination holdup tank cell has a floor drain and 18 in. thick shielding walls. Personnel access to this cell is gained via a doorway in the north wall that leads to the manipulator parking and maintenance area and then to the third-level corridor. Vessel access is provided by a blocked-in opening in the east wall, which adjoins the hot sump removal and access cell. The contents of the holdup tank (VES-NCM-123) are sampled from the gas and liquid sampling cell.

Ventilation air is supplied to this area from the calciner area H&V system at a rate of 400 cfm. The exhaust rate is slightly higher to prevent cross-contamination of any airborne contamination between this cell and the third-level corridor.

The 18 in. shielding walls reduce the radiation field from this cell to < 0.125 mR/h at a distance of 1 ft from the cold surface of the shielding wall in the third-level corridor, and 1.25 mR/h at a distance of 1 ft from the cold surface of the shielding wall in the manipulator parking and maintenance area.

Liquid spills in this area are confined by the stainless steel cell floor, which is equipped with a drain leading to the hot sump tanks. The cell floor drainline is provided with a bubbler probe leak detection system. Airborne contaminants are confined by the filtered H&V exhaust system. The H&V air is filtered by one prefilter and two HEPA filters installed in series.

Fire protection for this cell is provided by an overhead wet-pipe sprinkler system.

2.4.3.3.11 Hot Sump Tank Removal and Access Cell (205)—The hot sump tank removal and access cell contains the valve-operating area and provides access for tank removal from the decontamination collection tank cell, the decontamination holdup tank cell, and the hot sump tank cell. This cell is also used for the temporary storage of filters until they can be processed through the filter-leach system. A hatch is provided in the floor of the valve operating area for personnel access to the valve room and hot sump tank cell.

The hot sump tank removal and access cell, which includes the valve operating area, has about 780 ft^2 of floorspace. All walls are concrete with epoxy coating. Ceiling hatches are provided in this cell to facilitate removal of equipment and vessels from the adjoining cells identified above. The vessels and equipment can be lifted by the maintenance area 30 ton overhead crane. Personnel access to this area is gained from the third level via the entrance to the adsorber and off-gas cells.

Ventilation air is supplied to this area at a rate of 2850 cfm by the calciner area supply air system and is exhausted to the main exhaust tunnel on the third level. Pressure differentials ensure airflow from areas with lesser contamination potential to areas with greater contamination potential. Overhead shielding provided by the ceiling and its hatches is adequate to limit the maximum radiation exposure rate to 0.125 mR/h at a distance of 1 ft above the maintenance area floor. The surrounding concrete cell walls limit the maximum radiation exposure rate from adjacent cells to < 1.25 mR/h at a distance of 1 ft from the cell walls.

A breach of primary confinement in this area (e.g., pipe leaking radioactive solution) does not result in a release of radioactivity to the environment or exposures to plant personnel, because the cell and its HEPA-filtered H&V system provide adequate confinement of all radioactive contaminants including airborne material.

Breach of primary confinement (piping or vessels) in the hot sump tank cell does not affect the hot sump tank removal and access cell because adequate shielding has been provided for penetrating radiation and the H&V flow patterns prevent airborne contaminants from migrating into this area.

Internal decontamination of piping and valves in this area is conducted routinely to maintain ALARA radiation fields. Maintenance activity in this area is infrequent and requires direct hands-on techniques. RCT surveillance is also provided to help ensure exposures are ALARA.

Hot sump tank cell hatches are sized to facilitate equipment removal for maintenance, replacement, or decommissioning activities.

A 30 ton bridge crane (CRN-NCM-901) with an auxiliary hoist and a PaR Model 3000 bridge-mounted manipulator (CRN-NCM-902) are provided for vessel removal for maintenance and replacement.

Internal decontamination of the hot sump tanks is accomplished by adding fresh decontamination solution and recirculating it in the normal manner. Cell sprays are provided for external decontamination of the process equipment.

2.4.3.3.12 Return Jet Cubicle (222)—The return jet cubicle contains the return jets (JET-NCC-505-1 and -2) and the diverter valve (TA-8). The cubicle provides confinement and radiation control for any contamination release from any of the components in the cubicle.

The main components of this cubicle are the jets, the diverter valve, and the flow element. The product transport line (3"-TAAB-1802) also passes through the cubicle. The return line enters the cubicle and splits via the diverter valve into two return lines with a return jet in each line.

The return jet cubicle functions include the following: (1) providing a dedicated area for operation of the jets and to perform maintenance activities, (2) confining any material released from the jets or other components within the cubicle, and (3) providing adequate radiation shielding of the cubicle components.

The calciner area H&V system serves the cubicle. The H&V system, coupled with a metal hatch cover over the entry into the cubicle, maintains contamination confinement. The cubicle is provided with a floor drain (2"-PLAD-4231) as well as drains from the transport encasement.

Shielding is provided by the cubicle walls and floor, all of which are 2 ft thick and constructed of high-density concrete. Shielding also is provided around the product transport line as it passes through this room.

2.4.3.3.13 Return Jet Change Room (221)—No major components are located in the return jet change room. However, drainlines from the return jet cubicle and the transport line, which is shielded, pass through this area.

The room provides a protected change area for personnel entering and leaving the return jet cubicle. The room is served by the calciner area H&V system. The H&V system helps protect the room from contamination from the return jet cubicle. Personnel in the room are protected from radiation fields in the return jet cubicle by the 2 ft thick high-density floor of the return jet cubicle.

2.4.3.3.14 Manipulator Maintenance and Parking Area (218)—This area provides a parking spot for the manipulator (CRN-NCC-914) that serves the valve cubicle. In addition, the area provides a protected area in which the manipulator can be maintained by hands-on techniques.

This area has no major components. Entrance to the decontamination holdup tank cell is gained through the south end of the cell. Shielding from the filter cell is provided by a 5 in. thick steel shielding door.

The area provides a location to park and maintain the manipulator (CRN-NCC-914). The area is served by the calciner area H&V system. The system ensures all inflow into the area is from areas with lesser contamination potential to areas with greater contamination potential.

Radiation protection against the valve cubicle-filter cell area is provided by shielding door 323B. A labyrinth entryway into cell 219 provides radiation protection against the decontamination holdup tank.

2.4.3.3.15 Miscellaneous Third-Level Areas—In addition to containing the process cells, the third level contains several miscellaneous areas including a freight elevator equipment room (210) and a personnel self-monitoring and decontamination area (208).

Stairways and freight elevator service are provided for the third level. A series of double-door-type passageways are provided at all service openings for contamination control. Self-monitoring equipment and a personnel decontamination area also are provided for contamination control and personnel safety. The ventilation control maintains airflow patterns from areas with lesser contamination potential to areas with greater contamination potential.

Fire protection is provided for all the normally occupied miscellaneous areas by the NWCF automatic wet-pipe sprinkler system.

2.5 Process Description

The calcining process at the NWCF operates by spraying (atomizing) a blended liquid waste into a fluidized-bed calciner vessel (VES-NCC-105) that uses air as the atomizing gas for the feed nozzles. With the exception of the startup bed, which is composed of dolomite [$CaMg(CO_3)_2$], the fluidized-bed media are composed of calcined solids. During operation, bed particle growth from solids deposition is offset by particle attrition and bed withdrawal. Process heat for the NWCF is provided by burning kerosene (No. 2 fuel oil) or solvent that may contain tributyl phosphate (TBP) (used solvent) with pure oxygen in the fluidized bed. Solids produced in the calcining process are pneumatically conveyed through a double-contained stainless steel line (encased in concrete) to solids storage bins.

Off-gas from the calciner passes through a combination wet and dry cleanup system prior to discharge to the environment via the APS and the INTEC Main Stack.

Waste solution is transferred by steam jet or airlift from the existing 300,000 gal underground stainless steel storage tanks to the waste blend or hold tanks for temporary storage and adjustment (feed complexing, blending, etc.). Primary confinement of radioactive process solutions is provided by the process equipment (vessels, piping, etc.). Secondary confinement is provided by the process cells and the ventilation system.

Safe and controlled solution transfers from the storage tanks to the NWCF are ensured by the following:

1. Supervisor or foreman approval of all waste transfers

2. A pre-transfer check of the Tank Farm-to-NWCF transfer route (e.g., valve positions)

3. Operational level- and density-indicating and alarm instruments to provide operating personnel with adequate information to control solutions and prevent flooding in the blend (VES-NCC-101), hold (VES-NCC-102 and -103), and feed (VES-NCC-104) tanks

4. Constant communication between the Tank Farm operator and the NWCF operator confirming the transfer of radioactive liquid waste to the blend or hold tanks

5. Manual activation of the remotely operated inlet valves (LV-101-1, LV-102-1, and LV-103-1) to the blend and hold tanks upon completion of a transfer.

In case of abnormal operation (operator error, loss of communications, etc.) during liquid waste transfers from the Tank Farm to the blend (VES-NCC-101) or hold (VES-NCC-102 and -103) tanks, the maximum liquid level in the blend tank is controlled by an automatic shutoff system. This shutoff system consists of (1) a level transmitter and (2) a remotely operated pneumatic valve (LV-101-1) on the inlet to the blend tank from the Tank Farm. If the liquid level reaches high alarm, an electronic signal activates the pneumatic remote valve operator and closes the inlet valve to the blend tank. An overflow line routed to the fluoride hot sump tank (VES-NCC-119) is provided. Therefore, if the operator fails to take action and the automatic valve shutoff control system fails, the blend and hold vessel and the associated process and instrument piping will not flood.

The HLLWE, located in the blend and hold cell, is used to further concentrate Tank Farm solutions to a nominal specific gravity of 1.3. It is more cost-effective to concentrate by evaporation than by calcination. The HLLWE handles feed from the Tank Farm and is able to run independently of calciner operations.

Various waste in predetermined proportions is blended with feed additives and recycle solution from the off-gas scrubbing system or liquid waste collection systems before the blended feed is metered to the fluidized bed. Blended feed from a hold tank is airlifted to the constant-head feed tank from which the feed flows by gravity through flow control valves, flowmeters, and then up to four atomizing nozzles in the calciner vessel walls.

Liquid waste is calcined by introducing the air-atomized blended feed solution into a bed of heated oxide particles that are fluidized with air in the calciner vessel. Solids are removed from the fluidized calciner bed as product and from the off-gas as entrained solids.

Heat is supplied to the bed particles by in-bed combustion (IBC) of kerosene or a combination of kerosene and waste organic solvents in the presence of pure oxygen. Process heating for startup is supplied by heated fluidizing air. With IBC, the fuel is atomized with oxygen and sprayed directly into the bed where spontaneous ignition and continuous combustion provide the process heat required by the endothermic calcination reactions.

Particle size must be maintained large enough to prevent excessive elutriation, yet small enough for good heat transfer and to minimize the quantity of gas required for fluidization. Experience indicates that a mass mean particle diameter (mmpd) of 0.2 to 0.6 mm is suitable. This size range has minimal solids carryover in the off-gas from the calciner and has provided sufficient fine material to furnish seed particles for maintaining a stable bed particle size. Calciner product removed from the bed and fines removed from the off-gas by a cyclone are pneumatically transferred to underground storage bins.

A combination wet and dry off-gas cleanup system is used to remove radioactive particles and selected volatiles as well as to cool the calciner off-gas. Most of the solids in the calciner off-gas are removed by the dry fines collector, or the cyclone (VES-NCC-107), located near the top of the calciner vessel. Additional particulate removal occurs in the quench tower (VES-NCC-109) and in the venturi scrubber (VES-NCC-511), where calciner off-gas is cooled and scrubbed with a nitric acid scrub solution. Liquid droplets of scrub solution and de-entrained solids are removed in a de-entrainment separator and mist eliminator (VES-NCC-110) downstream from the condenser. Liquid is drained to the scrub solution hold tank (VES-NCC-108) for recycle to the cleanup system. When the acidity of the scrub solution becomes low, some of the solution is recycled to the hold tanks and fresh or recycled nitric acid is added to the scrub solution hold tank.

The off-gas next passes through a shell-and-tube-type heat exchanger, the adsorber superheater (HE-NCC-334) which may be used to maintain the off-gas temperature above the dewpoint before entering the ruthenium adsorbers. The ruthenium adsorbers (VES-NCC-112, -113, and -114) consist of columns packed with a regenerable adsorbent (silica gel) that selectively adsorbs volatile ruthenium from the calciner off-gas. Additional moisture and particulate removal is provided by mist collector (VES-NCC-116) downstream from the adsorbers. Prior to passing through the final stage of filtration, the off-gas is superheated to prevent water vapor condensation on the final filters. The off-gas then passes through four parallel filter housings (F-NCC-130-1, -2, -3, and -4). Typically, two filter housings are on-line during calcination. Each filter housing includes a prefilter stage followed by two stages of HEPA filtration. After leaving the HEPA filters, NWCF off-gas is routed through the off-gas compressors (BLO-NCC-243-1 or -2) then through the APS and to the INTEC Main Stack. Backflow of off-gas is prevented by the pressure differentials of interfacing systems.

Highly radioactive calcine is pneumatically conveyed to stainless steel solids storage bins, where entrained solids are removed by the cyclone. The storage bins are housed in concrete vaults that provide convective or forced-air cooling. Vault cooling air is diverted through HEPA filters upon detection of radiation (i.e., breach of the primary confinement integrity of the bins). Pressure and vacuum relief valves are used to protect the storage bin confinement integrity. Transport air is returned to the top of the calciner vessel.

The nitric acid used in the off-gas cleanup system can be fresh 13 M or low-level radioactive < 13 M from the nitric acid recycle tank (VES-NCR-171). The nitric acid in the recycle tank is produced in the LET&D fractionator. The nitric acid is transferred underground to the nitric acid recycle tank in double-contained Type 304L stainless steel pipe running adjacent to the Olive Avenue utility tunnel. The recycle tank is contained in a vault lined to a height of 56 in. with Type 304L stainless steel to provide a secondary containment with a volume of 110% of the tank volume plus 20 minutes of firewater flow at 570 gpm. The vault also contains a Type 304L stainless steel-lined sump to contain any leaking or spilled nitric acid.

An airlift (AL-NCR-550) is used to transfer nitric acid from the nitric acid recycle tank (VES-NCR-171) to the nitric acid recycle head tank (VES-NCR-173). The nitric acid gravity drains to either the scrub solution hold tank (VES-NCC-108) or the mist eliminator (VES-NCC-110) for use in the off-gas system as required. The nitric acid may also be drained to the fluoride hot sump tank (VES-NCC-119) for transfer to the Tank Farm or PEW. Overflow of the head tank drains back to the nitric acid tank (VES-NCR-171). In the event of tank or piping failure within the nitric acid recycle tank vault resulting in nitric acid entering the sump, a steam jet (JET-NCR-506) in the sump allows the nitric acid to be jetted to either the scrub solution hold tank or the mist eliminator. Any spilled or excess nitric acid also may be routed to the fluoride hot sump tank (VES-NCC-119) for transfer to the Tank Farm or PEW. The vault contains an acid monitor for personnel protection.

The capability for decontaminating process equipment in place is provided by permanently installed decontamination lines and internal sprays. Also, each of the cells and cubicles has spray headers for external equipment and cell or cubicle decontamination.

In areas with remote equipment changeout capability, contaminated equipment is disconnected and transferred to the remote decontamination cell (308) for remote disassembly and decontamination.

POG filters that require replacement are remotely transferred from the filter cell (216) or the hot sump tank removal and access cell (205) to the filter handling cell (309) where the filters are remotely leached, rinsed, dried, and packaged for shipment to the RWMC. Filters are transferred from other INTEC facilities and similarly processed in the filter handling cell.

Waste solutions from throughout the facility drain by gravity or may be transferred by steam jet to one of three waste sump tanks. The fluoride hot sump tank (VES-NCC-119) collects fluoride-bearing waste solutions. The nonfluoride hot sump tank (VES-NCC-122) collects nonfluoride waste solutions. With the phaseout out of fuel reprocessing, high-fluoride solutions are no longer processed in the NWCF. Thus, the fluoride hot sump tank still collects the same solutions but they are lower in fluoride concentration. The decontamination area holdup tank (VES-NCD-123) is used for collecting decontamination area waste solutions. This waste is disposed of by transfer to the NWCF blend and hold tanks for calciner feed to the PEW evaporator system for concentration, or to the INTEC liquid waste storage tanks for storage.

2.5.1 Calcination

2.5.1.1 Feed Solutions and Processing Rates. The NWCF provides a facility for solidifying radioactive liquid waste generated at the INTEC. Historically, the possible types of radioactive liquid waste generated at the INTEC were physically segregated into eight basic categories, which are listed in Table 2-29. The typical chemical compositions of the waste types are provided in Table 2-30. However, only sodium-bearing liquid waste is presently being generated.

To prevent fluoride from volatilizing during the calcination process, calcium nitrate is added as a solution to the feed in a mole ratio sufficient to complex fluorides in the waste feed (0.55 mole of calcium per mole of fluoride). For some blends, a calcium-to-fluoride ratio of 0.7 is used to maintain good particle properties. The addition of the calcium nitrate increases the waste volume by 15 to 20%, which decreases the net throughput of the calciner. Recycle of scrubbing solution from the off-gas system to the feed stream is estimated to be about 15% of the gross feed rate in the NWCF. The design-basis gross feed rate for NWCF was based on aqueous calcium nitrate addition.

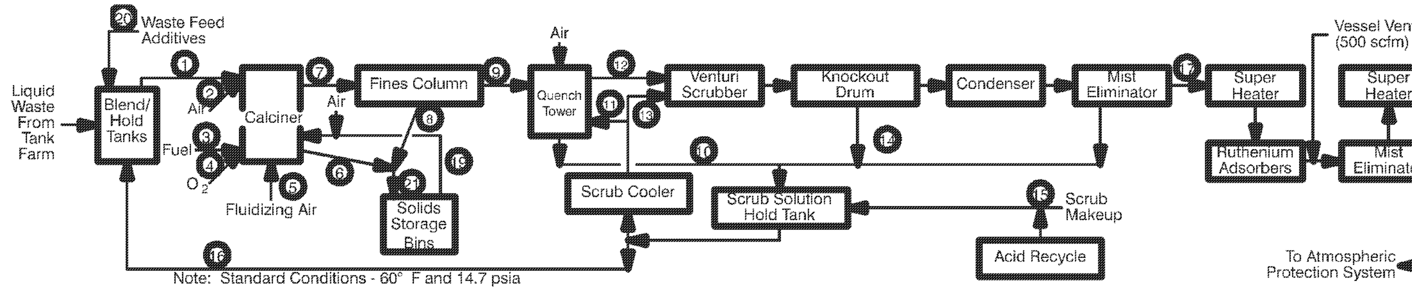
A typical flowsheet for NWCF operation and a schematic of the NWCF are illustrated in Figures 2-10 and 2-11, respectively.

Table 2-29. Types of INTEC radioactive liquid waste.

Type	Source
Aluminum waste	Dissolution of aluminum fuels in HNO_3.
Zirconium fluoride waste	Dissolution of zirconium fuels in HF.
Sodium-bearing waste	PEW evaporator bottoms and sodium-bearing decontamination solutions.
Coprocessing waste	Dissolver product from the dissolution of aluminum fuels is used as the complexing agent for zirconium dissolver product before introduction to the extraction system.
Fluorinel waste	Dissolution of zirconium fuels in HF and HNO_3.
Stainless steel waste	Electrolytic dissolution of stainless steel fuels in HNO_3.
Rover waste	Dissolution of graphite-type fuels in HNO_3 and HF.
Custom processing waste	Second- and third-cycle raffinate resulting from the processing of custom fuels.

Table 2-30. Chemical composition of various waste types (molar).

	Aluminum Waste			Zirconium Waste			Sodium Waste			Fluorinel Waste			Stai
Component	Typ	Min	Max	Typ	Min	Max	Typ	Min	Max	Typ	Min	Max	Typ
Acid (H^+)	1.0	0.6	1.2	1.5	1.3	1.7	1.2	0.4	1.8	1.9	1.8	2.0	2.5
Nitrate (NO_3)	4.6	4.5	5.4	2.6	2.4	2.7	4.6	3.7	5.0	2.3	1.9	2.5	3.0
Fluoride (F)	0.0	0.0	0.1	2.5	1.7	2.9	0.05	0.03	0.16	2.7	2.2	3.3	0.0
Aluminum (Al)	1.3	1.1	1.7	0.6	0.5	0.7	0.6	0.4	0.8	0.3	0.2	0.4	0.65
Zirconium (Zr)	0.0	0.0	0.01	0.4	0.2	0.5	0.0	0.0	0.01	0.4	0.3	0.4	0.01
Boron (B)	0.01	0.01	0.04	0.15	0.1	0.2	0.01	0.005	0.012	0.2	0.1	0.24	0.0
Cadmium (Cd)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.13	0.1	0.15	0.0
Sulfate (SO_4)	0.01	0.0	0.02	0.0	0.0	0.0	0.06	0.04	0.07	0.08	0.07	0.1	0.06
Sodium (Na)	0.04	0.03	0.07	0.04	0.04	0.09	1.6	1.1	2.1	0.03	0.02	0.05	0.01
Potassium (K)	0.003	0.001	0.005	0.007	0.007	0.02	0.2	0.15	0.22	0.001	0.001	0.002	0.0
Iron (Fe)	0.01	0.005	0.02	0.01	0.005	0.02	0.02	0.01	0.03	0.01	0.005	0.02	0.06
Chromium (Cr)	0.0	0.0	0.0	0.0	0.0	0.0	0.003	0.0	0.005	0.0	0.0	0.0	0.01
Calcium (Ca)	0.06	0.02	0.1	0.02	0.01	0.05	0.04	0.04	0.09	0.02	0.01	0.03	0.005



Stream	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Description	Calciner Feed	Atomizing Air	Fuel	Fuel Atomizing	Fluidizing Air	Calciner Solids	Calciner Off-Gas	Fines Column Solids	Fines Column Off-Gas	Quench Recycle	Scrub to Quench	Quench Off-Gas	Scrub to Venturi	Knockout Drum Recycle	Scrub Makeup	Scrub Recycle	Mist Eliminator Off-Gas	Off-Gas	Transport Gas Re
Total Solids, lb/hr					220	55-150	55-150	20-50										
Waste Feed Solution, gph	214																	
Recycle Solution, gph															32			
Scrub/Quench Solution, gph									(3800)	3800		1200-2400	1200-2400	8				
Kerosene, gph		29.4																
Air, scfm	130			325		795		795			825					885	1386	80
O_2, scfm			120															
Water Vapor, scfm						613		613			613					540	540	
CO_2 + CO, scfm						89		89			89					89	89	
						1497		1497			1527					1515	2015	

Figure 2-10. Calciner flowsheet.

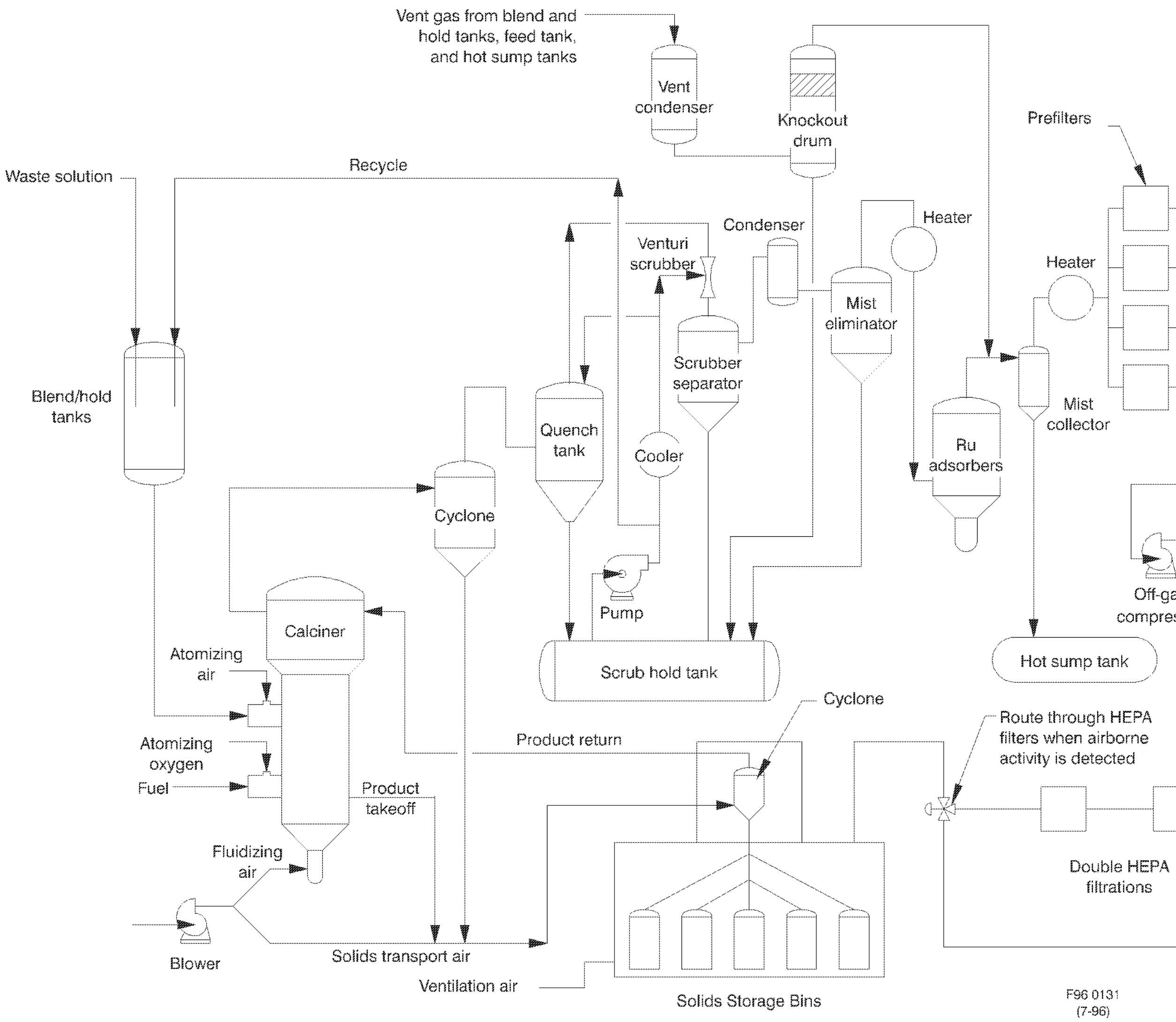


Figure 2-11. Schematic of NWCF and Off-Gas System.

The heat for the calcining process is provided by the combustion of hydrocarbon fuel within the fluidized-bed material. The fuel (kerosene or waste organic solvents atomized with pure oxygen) burns in the fluidized bed and releases the heat of combustion directly to the calcination process. The process is started by heating the fluidized bed with preheated fluidizing air. When using kerosene as fuel for the bed, the bed is heated to a minimum of 340°C[b] (644°F) prior to initiating the kerosene flow. The temperature is above the autoignition temperature of the hydrocarbon fuel. The liquid waste is calcined at 500° to 600°C (932° to 1112°F).

2.5.1.2 Calciner Feed System. The feed system is capable of receiving waste from the underground storage tanks, blending and complexing this waste with the necessary additives (scrubbing solution recycle, calcium nitrate, etc.), and then metering the blended feed through atomizing feed nozzles to the fluidized bed in the calciner vessel. The system includes the following equipment:

1. Two waste hold tanks (VES-NCC-102 and -103) to receive and complex waste and additives
2. One blend tank (VES-NCC-101) to aid in feed blending
3. A hopper (HO-NCM-846) and two auger transfer systems (CVR-NCM-446-1 and -2) to meter solid calcium nitrate in specific quantities to the waste feed hold tanks
4. Two tanks (VES-NCM-134 and -135) to receive and store liquid calcium nitrate and boric acid. They also supply liquid calcium nitrate to the calcium nitrate solution tank (VES-NCM-120)
5. A calcium nitrate solution tank (VES-NCM-120) to meter liquid calcium nitrate solutions to the waste feed hold tanks
6. An airlift on each of the tanks to transfer waste from the blend tank to the hold tanks or from the hold tanks to a constant-head feed tank (VES-NCC-104)
7. A feed tank (VES-NCC-104) that provides a continuous source of feed at a constant head. The feed tank, by providing a reservoir of feed solution, allows switching from one waste hold tank to the other without disrupting feed operations and acts as a disengaging pot for the airlifts
8. Feed flowmeters (FE-105-1 through -4) to measure the feed rate to the feed nozzles
9. Feed control valves (FV-105-1 through -4) to regulate the feed flow to the feed nozzles. Feed flowmeters and feed control valves are not located in the calciner cell but in the adjacent flowmeter cubicle (314) for maintenance using remote-manipulator-type equipment
10. Four feed nozzles to atomize the feed as it enters the calciner vessel.

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b. The temperature monitoring instruments for the fluidizing air, vertical calciner vessel thermocouples, and POG read out in degrees Fahrenheit. The temperature instrument (T105-1C) and the temperature rake for the calciner vessel read out in degrees Celsius. In this chapter, therefore, when the temperature reference pertains to instruments that read out in degrees Fahrenheit, the temperature is listed first in Fahrenheit with the equivalent temperature in degrees Celsius in parentheses and vise versa. This convention is not followed for figures and tables.

An existing 2 in. steam jet for each 300,000-gal underground waste tank is used to transfer the waste through a 3 in. underground line to an empty waste blend or hold tank at a rate of approximately 40 gpm. However, the two newest waste tanks use multistage airlifts. Scrub recycle is pumped into the waste hold or blend tank and mixed with waste feed at the specified ratio. Aluminum nitrate, calcium nitrate, boric acid, and other additives are added as required. The feed solution is then mixed by air sparging. A tank of blended feed is sufficient for about 16 to 18 hours of calciner operation.

Feed is transferred from a hold tank to the feed tank by an airlift. A constant head is maintained in the feed tank by airlifting at a rate greater than the feed rate. Excess feed flows back to the appropriate hold tank via the outlet in the bottom of the feed tank and the overflow line on the side of the feed tank. Solution leaves the feed tank through four side outlets. The feed flows by gravity through the flowmeter, a control valve, and finally a feed nozzle in the calciner vessel and into the fluidized bed. Air, introduced at the feed nozzle, atomizes the feed in the calciner vessel. Continuous NWCF operation is maintained by blending new feed in one waste hold tank while the other waste hold tank is being emptied.

2.5.1.2.1 Waste Hold Tanks—Two waste hold tanks (VES-NCC-102 and VES-NCC-103) are provided in the blend and hold cell (215) to permit complexing feeds, provide a point for sampling the calciner feed, and function as surge tanks to ensure continuous operation of the calciner.

The waste hold tanks are cylindrical vessels, which are mounted vertically and equipped with standard dished heads constructed of Nitronic 50 stainless steel. Nitronic 50 stainless steel is used because it has a higher resistance to corrosion by nitric acid and fluoride solutions than the Type 304L stainless steel used in the WCF. The tanks are constructed of approximately 3/8 in. thick plate; the bottom is approximately ½ in. thick. The vessel bottom is thicker because it is always wet, has several welded supports, and experiences more corrosion than other parts of the vessel.

The capacity of each tank is 3500 gallons. The operating volume is approximately 3000 gallons. Each tank is equipped with a cooling coil. Steam also may be supplied to the coil to heat the vessel contents during blending. Each vessel has an airstream sparger near the bottom and a decontamination spray nozzle near the top. The tanks vent to an equipment vent system (3"-VGAD-1739) that maintains a vacuum (~ 8 in. of W.C. vacuum) in the tank. Recirculation of decontamination solutions is via a steam jet.

Each waste hold tank (VES-NCC-102 and -103) can be emptied by a steam jet and a drain or through an overflow line to the fluoride hot sump tank (VES-NCC-119). By proper valving, the solution in a hold tank can be returned to the waste storage tanks or circulated within or between the hold tanks by steam jets. Each waste hold tank has a corresponding valve (LV-102-1 and LV-103-1) in the inlet line from the waste storage tanks that automatically closes at a high level to prevent overfilling the tank.

Sample lines from the tanks to the gas and liquid sample cell (320) on the second level permit samples to be drawn from either tank. Alarms and readouts are located on the DCS in the control room. Each hold tank is equipped with liquid level, density-, and temperature-indicating and alarm instruments; rotameters on purges and sparges; and a pressure detector.

2.5.1.2.2 Blend Tank—The single blend tank (VES-NCC-101) is located in the blend and hold cell (215) with the two hold tanks. The tank has a capacity of approximately 5500 gal, is mounted vertically, and is constructed of the same materials as the hold tanks with the same material of construction as the hold tanks. The tank also has the same instruments and cooling, heating and sampling capability as the hold tanks. The blend tank also is equipped with a heating coil.

The main purpose of the blend tank is to accurately mix and blend different types of radioactive waste. Because there can be a large volume and density change when two types of waste are mixed, the weight or volume of feed additives are premeasured prior to mixing in the hold tanks.

2.5.1.2.3 Calcium Nitrate and Boric Acid Addition—Calcium nitrate is added to the waste feed to complex fluoride ions. Complexing forms calcium fluorozirconate, which reacts to form calcium fluoride during calcination and minimizes fluoride volatilization. Boric acid is added to prevent formation of insoluble alpha-alumina compounds.

In the NWCF, one method for the addition of calcium nitrate or boric acid is to transfer liquid either calcium nitrate or boric acid into the calcium nitrate solution tank (VES-NCM-120) from the liquid storage tanks (VES-NCM-134 and -135). The two storage vessels receive and store liquid calcium nitrate or boric acid that is bought commercially premixed at the concentrations required for use in the feed solution. The premixed solution is trucked to the unloading station at the CPP-659 east loading dock. The premixed solution is sampled prior to unloading and transferred into the storage tanks by pressurizing the tanker truck with 35 psig of air. The premixed calcium nitrate or boric acid solution is transferred from the storage tanks (either VES-NCM-134 or -135) to the calcium nitrate solution tank (VES-NCM-120). The storage tanks are equipped with two pumps. Each pump can be used to recirculate and transfer the liquid calcium nitrate or boric acid to the calcium nitrate solution tank (VES-NCM-120).

Another method for calcium nitrate addition is to add solid calcium nitrate directly to the hold tanks. Solid calcium nitrate can be added to the waste hold tanks by a hopper-auger feeder transfer system. Bags of calcium nitrate are mechanically lifted to the calcium nitrate hopper (HO-NCM-846). The bags are split manually, and the calcium nitrate falls through a ½ in. mesh screen and into the bottom of the hopper. From this point, the material travels to an appropriate hold tank addition line via a flexible tube and screw conveyor. During solids addition, the contents of the hold tank are vigorously sparged, recirculated, and heated to 104°F (40°C) to aid in the dissolution of the calcium nitrate.

The last method for calcium nitrate addition is the makeup of liquid calcium nitrate or boric acid solution in the calcium nitrate solution tank (VES-NCM-120). Water is added to the calcium nitrate solution tank (VES-NCM-120) and heated via the steam jacket. Solid calcium nitrate or boric acid is added to the hopper (HO-NCM-846), and this material is transferred to the calcium nitrate solution tank via the flexible tube conveyor (CVR-NCM-446-2). The solids are stirred with a mixer until they are dissolved, and then the solution is added to a hold tank (either VES-NCC-102 or -103). The solution cannot be added if the hold tank is not under vacuum. If the tank should pressurize during liquid addition, the escape of gases to the calcium nitrate solution tank is minimized by the liquid head in the calcium nitrate solution tank and two check valves that are located in series in the addition line. Additional isolation can be accomplished by closing the three manual block valves that also are located in the addition line.

Instruments for the liquid addition system include diptubes for liquid level and density measurements and a temperature indicator.

2.5.1.2.4 Airlifts—Three airlifts (AL-551-1, -552-1, and -553-1) are used to transfer feed solutions from the blend and hold tanks. The airlifts are in a pit in the valve cubicle below the floor level of the blend and hold cell. The airlift loops are flanged for remote removal, and a remotely operated block valve is located on the inlet and outlet of each airlift. Normal operation of the airlifts is achieved by introducing air and steam into the liquid on the lift side of the U-shaped airlift. Differences in liquid density cause the lighter leg to rise to the feed tank where air and steam are disengaged from the solution. Excess liquid returns to the hold tanks via an overflow line. Steam can be used with the air to raise the fluid temperature and decrease plugging problems caused by large amounts of undissolved solids. Airflow to the airlift is regulated by a remotely operated control valve (located in the operating area) and controlled from the control room (438) by a manually operated electronic-indicating control station on the panelboard. Airlifts and associated feed piping are fabricated of Nitronic 50 stainless steel.

2.5.1.2.5 Feed Tank—Feed is transferred from the waste hold tanks to the feed tank (VES-NCC-104) by the airlifts either through line 2"-PSAB-1704 or 2"-PSAB-1705. The feed tank provides a constant head of liquid feed for the calciner feed nozzles. This is accomplished by airlifting solution to the feed tank faster than the process rate and overflowing excess feed back to the waste hold tanks.

The feed tank is located on the east wall in the blend and hold cell. This vessel is a vertical cylindrical tank with a semi-elliptical head and a conical bottom and is constructed of Nitronic 50 stainless steel. The bottom and sides are approximately 5/16 in. thick, and the top head is approximately ¼ in. thick. The volume at overflow is about 74 gal.

Airlifts discharge into the feed tank about 6 in. above the overflow level and 6 in. below the top tangent line. The outlets (1/2"-PSAB-1706, -1707, -1708, and -1709) from the feed tank are located about 5 in. above the bottom tangent line of the tank. A sparge line (1/2"-LAAF-3851) in the bottom of the feed tank helps prevent solids from settling in the bottom of the vessel. If solids still accumulate, a steam jet (JET-NCC-504) equipped with a diptube at the bottom of the feed tank can be operated periodically to remove accumulated solids and discharge them to the hot sump tank. The outlet lines extend approximately 12 in. inside the feed tank and are perforated with approximately 3/16 in. diameter holes on an approximate 3/8 in. triangular pitch. These holes strain out any large particles that might plug the atomizing feed nozzles. The feed tank has a level-indicator alarm (high and low), a pressure indicator, and a temperature indicator. The indicating and alarm instruments are located on the DCS. The feed tank vents to the equipment vent system (2"-VGAD-1736).

2.5.1.2.6 Feedflow Control—A flowmeter and a control valve in each feedline controls the flow to each feed nozzle. The flowmeters (FE-105-1, -2, -3, and -4) and control valves (FV-105-1, -2, -3, and -4) are installed in the flowmeter cubicle (314), which is equipped with remote manipulators and an overhead monorail crane. The flowmeter cubicle is located adjacent to the east wall of the blend and hold cell and the north wall of the calciner cell. The electromagnetic-type flowmeters consist of an unobstructed section of pipe lined with ceramic insulator. Diametrically opposed platinum cylindrical electrodes are mounted in the central portion of the pipe section and are completely insulated from the pipe. The end surfaces of the electrodes are flush with the inner surface of the insulating liner permitting them to contact the fluid to be metered.

A field coil assembly, consisting of two square magnet coils that surround the central arms of two E-shaped laminated iron cores, completely encompasses the central portion of the pipe section. The field coil assembly produces a linear and uniform magnetic field through the metering section of the flowmeter for flow rates ranging from 0 to 100 gph. The signal from the flowmeter is transmitted to a flow recorder-controller that controls a full port ball valve located downstream from the flowmeter.

The feedlines are as short as practicable and have a substantial slope to encourage the movement of solids through the lines.

2.5.1.2.7 Feed Nozzles—The radioactive liquid feed is atomized with air at each feed nozzle and is sprayed into the calciner vessel. The volume of nozzle air varies from 300 to 2400 scfh. Flow indication and flow control are provided by remotely operated flow control valves. These valves are controlled by the DCS located in the control room.

Flush water, an air purge, and decontamination solutions can be added to the feedlines upstream or downstream from the control valves to aid in cleaning the nozzles, feed valves, and feedlines. The flushwater normally is regulated from the control room but may operate automatically following activation of the rapid shutdown system (RSS).

Feed nozzles are installed on the calciner vessel in a manner permitting them to be replaced using the calciner cell master-slave manipulators.

2.5.1.2.8 Decontamination—The feed system is decontaminated by introducing decontamination solution into the hold tanks, the blend tank, or the feed tank through the decontamination spray nozzles or through a sprayer inserted through the vessel's manhole. To decontaminate the feed piping, the feed tank, flowmeters, and nozzles, the solution is airlifted to the feed tank and then gravity-fed to the calciner in the same manner as waste feed. After the solution is transferred to any of the blend and hold cell vessels, it is heated, recirculated, and agitated. Recirculation of decontamination solutions minimizes the quantity of waste generated.

2.5.1.3 Calciner Vessel System. Calcination of radioactive waste is accomplished by spraying the liquid through atomizing nozzles into a fluidized bed of particles that is heated by the combustion of hydrocarbon fuel and oxygen. The dissolved metals and fission products in the liquid waste react at the 500° to 600°C (932° to 1112°F) calcination temperature forming solids (primary oxides) that coat the surfaces of the bed particles. Solid product is withdrawn continuously or batchwise from the bed and pneumatically transferred to stainless steel bins housed in underground concrete vaults for retrievable storage.

2.5.1.3.1 Calciner Vessel—The calciner vessel (VES-NCC-105) is a vertical cylinder with an expanded upper section, an elliptical head, and a conical bottom. The upper section is 7 ft in diameter and approximately 12 ft high. It contains two layers of deflection or baffle plates to minimize the amount of solids that is carried out of the vessel in the off-gas stream. The lower section is 5 ft in diameter and approximately 7 ft high and contains the fluidized bed. The vessel is constructed of Type 347 stainless steel and weighs about 35,000 lb. The vessel has been evaluated for an upper operating temperature of 700°C (1292°F) and an internal pressure range from -12.3 to +11 psig. Nominal operating conditions range from 500°C to 600°C (932° to 1112°F) with 42 in. of W.C. vacuum at the top of the vessel. The vessel is supported by steel beams that span from the south to the north cell walls. These beams are hardened to withstand the DBE and a 2 hour fire.

Some of the more important penetrations into the calciner vessel include the following:

1. A 1 in. double-extra-strong (XXS) solid sample and solids return line

2. A ½ in. XXS liquid sample line

3. A 16 in. Schedule 60 off-gas outlet. This line was oversized to accommodate a second calciner vessel, which has never been installed

4. Four 3 in. Schedule 160 decontamination lines with spray nozzle assemblies

5. A 1 in. diameter XXS sparge ring located near the bottom of the vessel for adding extra fluidizing air and for providing agitation for decontamination solution

6. A 1 in. XXS decontamination spray for the conical portion of the calciner vessel

7. Two 2 in. special-forged product outlet lines
8. A 3 in. Schedule 160 distribution plate drainline
9. One 24 in.-diameter manway
10. Two 4 in. Schedule 160 transport air return lines
11. One 3 in. Schedule 160 dolomite addition line
12. Four 4.5 in. special-forged fuel inlets
13. Four 4.5 in. special-forged feed inlets
14. One 8 in. Schedule 80 fluidizing air inlet
15. Four 8 in. handholes
16. One 3 in. Schedule 160 thermowell connection for the temperature rake.

2.5.1.3.2 Distribution Plate—Fluidizing air enters the conical plenum chamber through an 8 in. diameter line (FAAC-2452-Ih) at the bottom of the vessel. The air is distributed through 36 holes in the 5 ft diameter distributor plate. The holes in the distributor plate are sized so that the pressure drop across the distributor plate is approximately 40% of the total pressure drop across the calciner bed. A bubble cap is positioned above each hole to increase the plate pressure drop (for uniform air distribution) to minimize bed attrition in the plate, which results from direct impingement of the fluidizing air on the bed material, and to keep the bed from draining into the plenum. In certain circumstances, additional fluidizing air may be distributed, if necessary, through a sparge ring located directly above the distributor plate.

2.5.1.3.3 Fuel Nozzles—Four fuel nozzles are equally spaced around the calciner vessel about 20 in. below the feed nozzles. The fuel nozzles are installed flush with the vessel wall. Nozzles internally mix fuel with oxygen and produce a wide-angle flame in the fluidized bed. Normally, four nozzles are used to supply heat to the bed. If necessary, any three nozzles have the capacity for supplying a total of 30 gal of fuel per hour, which is required for the design basis feed rate of 214 gph. The no. 3 nozzle is equipped to burn waste organic solvents supplied from the solvent storage tanks (TK-NCE-184, -185, and -186) as an alternative fuel to kerosene. The temperature of the fluidized bed is used to control the position of the fuel flow control valves.

Fuel nozzles are installed on the calciner vessel in a manner permitting them to be replaced using remote maintenance equipment such as manipulators.

2.5.1.3.4 Instrumentation—The basic calciner vessel instruments include the following:

1. Seven thermowell connections (1.5 in. in diameter, XXS) located vertically along the vessel
2. A temperature rake positioned horizontally about 3 ft 9 in. above the distribution plate. This rake contains five remotely removable TCs and is constructed of 3 in. Schedule 160 Type 347 stainless steel
3. Ten 1 in. XXS air-purged pressure taps, located vertically along the vessel.

The above-listed instruments provide data for determining the vessel pressure, the bed level, the bed density, the bed temperature, the fluidizing air temperature, the occurrence of above-bed burning, the degree of bed fluidization, etc. The pneumatic signals are converted to electronic signals and transmitted to the control room (438). The control instruments for the calciner vessel are designed to be highly reliable and to fail-safe. The following paragraphs describe in detail these control systems.

Temperature control for the calciner vessel is maintained from the control room by using the average fluidized-bed temperature to adjust the fuel flow to the vessel. The average bed temperature is sensed by a temperature rake consisting of five electrically parallel Chromel-Alumel TCs (TE-105-1-1, -2, -4, -5, and -6) spaced across the diameter of the bed. All of the TCs are replaceable from outside the calciner cell. The five temperature signals are averaged and recorded continuously in the control room as DCS tag T105-1C. The output signal of the temperature rake provides continuous feedback (T105-1C) to the bed temperature or fuel flow control system. The output signal is a measurement of the average bed temperature with automatic compensation for individual TC failure.

Passive alarms are provided for low (382°C [720°F]) and high (625°C [1157°F]) bed temperatures. Active alarms trip the RSS and activate an automatic shutdown of fuel, oxygen, and waste feed should the bed temperature either rise above 650°C (1202°F) or fall below 340°C (644°F). The automatic high-temperature shutoff for fuel and oxygen prevents the bed temperature from exceeding the design temperature of the calciner vessel. The automatic low-temperature shutoff (~340°C [~644°F]) for fuel and oxygen prevents the possible accumulation of fuel vapor in the bed during a flameout when the temperature is below the autoignition point. A temperature probe (TE-105-4) in the top of the calciner vessel is used to detect above-bed burning. This condition can occur when the fuel is starved for oxygen in the bed. The temperature spread in the vertical sensing elements (TE-105-6 through -10) and the five points in the temperature rake can be used to judge how well the bed is fluidized. The closer the temperature spread is, the better the fluidization.

Each of the four fuel nozzle supply systems (one for each fuel nozzle) contains the same basic elements. Each kerosene supply line has a flow control valve (e.g., FV-105-6), a flow orifice (e.g., FT-105-6), high- and low-flow alarms, a flow indicator controller (e.g., F105-6C), a remote control block valve (e.g., FV-105-14), and an automatic air purge (e.g., ¼”-LAAF-3889). The waste organic solvent disposal line (which can be used to feed the no. 3 nozzle) is provided with the same instruments as the kerosene supply lines. A fuel selector located in the NWCF control room is used to activate the solvent disposal line instruments before the no. 3 nozzle is used to dispose of the waste solvents. Each oxygen supply line contains very similar components: a flow control valve (e.g., FV-105-10), a flow orifice (e.g., FE-105-10), high- and low-flow alarms, a flow ratio controller (e.g., FF105-10C), a remote control block valve (e.g., FV-105-18), and continuously operating air purges on each supply line. In addition to the oxygen system, the ratio controllers also have LO and LOLO ratio alarms that alarm at 1500 and 1077 (volumetric ratio of oxygen to fuel, dimensionless), respectively.

The above instruments operate in the following manner. The bed temperature signal (T105-1C) feeds into five flow-indicator controllers (F105-6C through F105-9C and F105-37C) that send out signals to operate the four flow control valves (e.g., FV-105-6) in each fuel line. The flowmeter signals (e.g., FT-105-6) are fed back into each flow-indicator controller (e.g., F105-6C). Should the flow rate through one fuel nozzle decrease without a corresponding decrease in the other nozzles (this may occur if a flow control or a block valve were to fail), the flow of fuel and oxygen through the other nozzles increases to maintain the correct fluidized-bed temperature. The fuel and oxygen flow to each nozzle is recorded, on the appropriate flow-indicator controller, on the DCS.

The fuel flow signal (FT-105-6) feeding into the ratio controllers (e.g., FF105-10C) adjusts the oxygen flow and maintains the volumetric ratio of oxygen to fuel. Thus, the proper ratio is maintained without regard for the given fuel flow rate, with the exception of the high-fuel-flow shutoff, demanded by the bed temperature control system. As long as the fuel flow rate remains within the preset operating envelope, activation of the LOLO alarm for the oxygen-to-fuel ratio on any nozzle control system energizes a time-delay relay for that system. This relay activates a solenoid valve that in turn closes positive shutoff valves in the fuel (e.g., FV-105-6 and FV-105-14) and oxygen (e.g., FV-105-10 and FV-105-18) lines of the affected system. The time delay period is 2 minutes.

The calciner vapor space is maintained at about 42 in. of W.C. vacuum by adjusting a combination of manual and automatic controls. Coarse adjustment is achieved by adjusting, from the control room, a butterfly valve (HV-243-1) in the suction line of the off-gas blowers. Once the coarse adjustment is attained, fine adjustments are automatically maintained via the signal from the pressure tap (1/2"-LIAF-1831) in the top of the calciner vessel. This pressure signal (PT-105-1) is used to control the calciner vessel vacuum by adjusting the amount of air that is allowed to bleed into the vent line (4"-VGAD-2022). This 4 in. vent line is connected to the quench tower (VES-NCC-109), and adjustments to the quench tower pressure cause corresponding changes throughout the off-gas cleanup system and the calciner vessel. Thus, an increase in the bleed airflow rate into the vent line (4"-VGAD-2022) causes the calciner vacuum to decrease, i.e., approach a positive pressure. If too much air is allowed to enter this control system, a low-vacuum alarm (P105-1C LO) activates at 30 in. of W.C. vacuum and a second low-vacuum alarm (P105-1C LOLO) activates at 20 in. of W.C. vacuum, which sends a signal to the RSS.

The level of the calciner bed is determined by measuring the differential pressure between a pneumatic probe (open-ended tubing purged with air) located in the vapor space above the bed and a probe located at the same elevation as the feed nozzles. Several additional probes are available and can be used for bed-level determination if necessary. The fluidized-bed density is determined by measuring the pressure drop between two probes in the bed separated by about 10 in. of elevation.

2.5.1.3.5 Bed Addition and Removal—Startup bed material ($CaMg[CO_3]_2$) is added to the calciner through a 3 in. diameter pipe (3"-TAAF-1826) entering the side of the vessel below the baffle assembly. The bed also is capable of being drained through a 3 in. diameter pipe (3"-PSAB-1828) penetrating the center of the distributor plate. The bed drainline and the plenum chamber drain are valved into the transport air system.

2.5.1.3.6 Insulation—The calciner vessel is insulated with a removable high-temperature insulation (chloride-free). The insulation is covered with a thin stainless steel jacket to protect the insulation from decontamination solutions that may be sprayed onto exterior equipment surfaces. The disengaging section also is insulated with a high-temperature chloride-free insulation covered with a thin stainless steel jacket.

2.5.1.3.7 Decontamination—Decontamination lines connect to spray nozzles located in the top of the vessel and a ring sparge below the distributor plate. A separate sparge ring above the distributor plate is supplied with air and steam for sparging and heating decontamination solution contained in the vessel.

2.5.1.3.8 Calciner Fluidizing Air System—The fluidizing air for the calciner vessel is supplied by either of two positive-displacement blowers (BLO-NCO-205-1 and -2), one of which is a spare. Fluidizing air passes through an inlet filter silencer (F-NCO-105-1 or -2), a blower (BLO-NCO-205-1 or -2), a discharge muffler (MU-NCO-905-1 or -2), a fluidizing air oil separator (F-NCO-106), a flow orifice (FE-205-1), and a throttling valve (FV-205-1) to two preheaters (HTR-NCO-305-1 and -2) and then to the calciner. The pressure, flow rate, and temperature are separately controlled. This equipment is located in the fluidizing air blower and heater rooms.

2.5.1.3.9 Blowers—Two single-stage positive-displacement blowers (BLO-NCO-205-1 and -2) are used to supply air for fluidizing the bed (8"-FAAC-2452) and transporting solids (3"-TAAF-2455) to the storage bins. These blowers are located in the fluidizing air blower room (315). Only one blower operates at a time. The operating blower delivers approximately 600 to 650 scfm of air at about 5.5 psig. The fluidizing air blower control system is equipped with alarm and automatic start circuitry. If the pressure drops to 3.0 psig, a pressure switch (PSL-205-2) activates a low-pressure alarm (PSL-205-2C). If the pressure drops to approximately 2.5 psig, a second pressure switch (PSLL205-1C) activates an alarm (PALL205-1C) and the automatic start circuit for the standby blower and stops the operating blower. Thus, complete stoppage of the fluidizing air is prevented unless the standby blower fails to operate. Automatic controls (the RSS) are provided for shutdown of the waste feed, process heating, and fluidizing air heater systems if both fluidizing air blowers fail or if the fluidizing air drops below 125 scfm.

Normal fluidizing and transport airflows are approximately 325 and 110 scfm, respectively. The fluidizing airflow rate is regulated by a flow indicator controller (F205-1C) receiving its signal from one of two transmitters (FT205-1A and FT205-1B) measuring the differential pressure across an orifice (FE-205-1). The throttling valve is an air-to-open valve and fails closed. An alarm (F205-1C LO) is provided for low fluidizing airflow below 150 scfm, and, if the flow drops below 125 scfm, another alarm (F205-1C LOLO) activates the RSS.

In the case of instrument failure, the fluidizing airflow can be regulated by manual control via valve (FA-10) located parallel to the throttling valve in the fluidizing air blower room (315).

Pressure control for the fluidizing air stream is regulated by a pressure indicator-controller (P205-3C) receiving its signal from a pressure transmitter (PT-205-3). The controller's signal activates a control valve (PV-205-3), that vents excess air to exhaust box no. 2 in corridor 212. Air entering this exhaust outlet passes through a prefilter and two stages of HEPA filters before being discharged to the atmosphere via the NWCF stack.

2.5.1.3.10 Fluidizing Air Preheaters—Fluidizing air is heated between 932 and 1112°F (500 and 600°C) by flowing through two electrical resistance heaters (HTR-NCO-305-1 and -2) connected in series. Heater control is maintained from the control room. The proper fluidizing air temperature is maintained by varying the power to the fluidizing air preheaters. The amount of power variation is regulated by a silicon control rectifier for each heater that receives input signals from the temperature indicator-controller (T305-1C). Temperature signals to the temperature indicator-controller come from TCs (TE-305-1 DUAL) located in the fluidizing air line immediately upstream from the calciner cell. A temperature-actuated indicator and alarm (T305-2C) that serves as an "override" for the temperature indicator-controller also is included in the control system. If the fluidizing air temperature reaches 1125°F (607°C), a high temperature indicator and alarm (T305-2C HI) is activated. At 1150°F (621°C), a high-high indicator and alarm (T305-2C HIHI) activates the RSS, which activates shutdown of the fluidizing air heaters. Excessive temperature rates on the fluidizing air piping are thereby avoided. Heater shutdown can also result from high heater-element temperature as detected by two TCs (TE-305-1-2 and TE-305-2-2).

To minimize heat losses, the fluidizing air preheaters are located as close as possible to the calciner cell, and the fluidizing air line downstream from the preheaters is insulated with chloride-free insulation covered with a thin stainless steel jacket.

2.5.1.3.11 Calciner Product Transportation System—The solids produced in the calcining process are conveyed pneumatically from the calciner vessel and off-gas cyclone to the stainless steel solids storage bins. A cyclone located above the stainless steel bins separates the solids from the air.

The transport line exits the calciner cell in a double-contained stainless steel line, passes under the third-level corridor, and extends up through the return jet cubicle change room (221) into the return jet cubicle (222). The product transport line (3”-TAAB-1802), the return line (3”-TAAB-1803), a spare line (3”-TAAB-106120), and a steam tracing line (1-1/2”-HSAF-1839) are encased in an 18 in. diameter line. The line travels underground to the concrete vault that houses the stainless steel storage bins. After the solids are separated by the cyclone, the transport air is routed back to the top of the calciner vessel via the return jet cubicle. The steam tracing heats the transport and return lines and thereby helps prevent condensation and possible plugging by solids.

The motive air for the solids transport line is supplied by the fluidizing air blowers (BLO-NCO-205-1 and -2). Some of the air from the discharge manifold of the fluidizing air blowers is routed through a 3 in. Schedule 40 carbon steel pipe (TANC-2454 Ih) to an orifice meter (FE-205-2), a flow control valve (FV-205-2), and then to a heater (HE-NCO-331) that is located in the second-level corridor near the calciner cell. The orifice meter (FE-205-2) is capable of measuring a maximum flow of 200 scfm. Flow measured by the orifice is recorded and connected to an alarm on the DCS. The first pressure-sensing point is monitored by a pressure transmitter (PT-205-4) just downstream from the flow control valve. This signal is recorded and alarmed on the DCS. Downstream from the heater, the fluidizing air line passes through a block valve, a conventional check valve, and then through the calciner cell wall. Beyond the cell wall, the transport air system lies in radioactive areas. Therefore, the block valve and all components downstream are fabricated of Type 300 series stainless steel. All components between the calciner cell wall block valve and the fluidizing air blowers are fabricated of carbon steel except the transport air heater, which is stainless steel and Nitronic 50.

Airflow into the transport line is controlled by volume (FE-205-2) or pressure (PT-105-11) at the discretion of the operator. This control system uses flow rate or pressure signals to adjust a flow control valve in the transport line and thereby maintain a constant flow rate or pressure in the transport line.

Airflow through the return line is controlled by the flow rate. A velocity and pressure control system is provided for the return line. Flow and pressure-sensing points are selected just upstream from the return jets. This control system bleeds air into the return line in the amount that is necessary to maintain constant velocity through the return line.

2.5.1.3.12 Cyclone Fines Removal—Cyclone fines and minimal amounts of POG are introduced into the transport air line via a 6 in. diameter cyclone drop leg or fines column. A fluidized addition funnel or pad and slide valve are located at the bottom of the leg to provide continuous or intermittent calcine discharge to the transport air line. Backflow into the cyclone can occur if a plug develops in the transport line. This condition disrupts the gas-solid flow patterns and thus reduces the cyclone’s collection efficiency.

2.5.1.3.13 Product Takeoff System—Two product takeoff lines extend from opposite sides of the calciner vessel. One of the takeoff lines is operated while the other is available as a standby. Each line exits the calciner vessel horizontally approximately 15 in. above the distributor plate and enters the 3 in. transport line via a vertical section. Two remotely operated slide valves (HV-105-2 and -3 for one line, and HV-105-8 and -9 for the other takeoff line) are located in the vertical section, and an air purge line connects between the two valves. With this arrangement, the line can be blown out in either direction. The line not in service is continuously purged with air (that flows back to the calciner vessel) to help prevent plugging. The air purge rate is detected by an integral orifice and regulated by a remotely operated control valve that is located in the second-level corridor.

A second air line is connected to each product takeoff line close to the junction of the line with the calciner vessel. Air introduced at this point controls the rate of product flow through the line. The solids product flow varies inversely to the airflow rate. This airstream is designated as dilution air. The flow rate is measured and controlled in the same manner as delineated for airlifts. A welded bar, ¼ in. in diameter, over the center of the product takeoff lines prevents large lumps of calcine from entering the product takeoff lines and possibly plugging them. This bar limits the maximum size of particles that can enter the takeoff lines to 3/16 in. in diameter.

2.5.1.3.14 Calciner Vessel Drains—The calciner plenum and air distributor plate drainlines connect to a horizontal run of a transport air line through a Y-connector to provide concurrent solids flow in the horizontal line (3"-TAAB-1802). Each of the 3 in. Schedule 80 drainlines connects to the transport air line through a slide valve that is operated remotely from the control room. Bars are placed over the inlet to the distributor plate drainline to prevent cakes or large pieces of foreign material from entering and plugging up the valve opening.

During normal operation the slide valves remain closed. During shutdown and bed removal, the slide valve in the air distributor plate drainline is used to control the flow of bed material into the transport air line. After the material above the distributor plate has been transferred to storage, the plenum drain valve is opened to transfer solids that have dropped below the support plate. At the start of the bed dumping operation, the pressure above the distributor plate is greater than the pressure in the transport air line, causing solids to flow freely into the transport air line. As the bed level decreases, the pressure above the distributor plate decreases (the vacuum above the bed is maintained constant), and the driving force for solids flow to the transport line could eventually become zero. To prevent this from happening, and also to create a greater driving force for the flow of transport air during the bed dumping operation, the pressure in the transport line is reduced by use of the transport air jet located in the return line from solids storage. High-pressure air lines just downstream from the slide valves in each drainline maintain a purge on the portions of the drainlines entering the transport line anytime that the valves are closed. This prevents plugs from forming in the latter portions of the drainlines.

2.5.1.3.15 Solids Transport and Return Lines—The 3 in. Schedule 80 stainless steel transport line (TAAB-1802) penetrates the east wall of the calciner cell about 3 ft under the third-level corridor. Once outside the calciner cell, the line is double-encased in stainless steel as the line travels under the third-level corridor, up through the return jet cubicle change room (221), and into the shielded return jet cubicle (222). Once inside the return jet cubicle, the product transport line and spare, the return line, and a steam tracing line are grouped together in an 18 in. diameter line that travels underground to the concrete vault, which houses the stainless steel storage bins. The return line (3"-TAAB-1803) follows the same underground route back to the NWCF. Schedule 80 piping is used for the transport and return lines.

The radiation level for the return lines as they traverse the third-level corridor is < 0.125 mR/h at a point directly below the lines and 6 ft above the floor. The solids transport line provides the only path for calciner solids removal from the calciner to the solids storage bins. Generally, most of the solids transport occurs in horizontal piping, though some vertical rise is required to transport the solids from belowgrade to the top of the solids storage bins. Straight vertical rises are used in preference to sloped rises. However, the latter are acceptable for the dilute phase transport rates encountered in this system. The transport line layout minimizes the number of changes in direction. Areas of high erosion, such as bends and elbows in the product transfer line, are made of blinded tees with wear pads and purge meters. The blinded tees collect calcine in the corner. The blinded tees act as buffers between the flowing calcine and the product transfer line piping.

Flow through the transport system is controlled by adjusting the flow through the transport line (3"-TAAB-1802) and the transport air return line (3"-TAAB-1803). While the control system for the supply line can be controlled by pressure or volume at the discretion of the operator, the return line is controlled by volume; however, the controlling mechanisms are different. The transport line uses a pressure or flow-rate signal to adjust the flow control valve (FV-205-2). The return line uses a control valve (FV-105-40) that bleeds plant air into the process line. An increase in plant airflow causes the pressure in the return line to increase and the flow to decrease.

The transport air line takes off from the fluidizing air stream (6"-FANC-2451 Ih) and is routed through the flow orifice (FE-205-2), the flow control valve (FV-205-2), and the heater (HE-NCO-331). The flow signal (FT-205-2) or the pressure signal (PT-105-11) can be used to adjust the flow control valve. This valve is designed to fail in the open position. However, control can be maintained by isolating the flow control valve (FV-205-2) with two block valves (TA-1 and TA-2) and then manually adjusting the flow through the bypass line via another block valve (TA-3).

The return line enters the return jet cubicle (222) and is monitored for temperature, pressure, and flow rate. This information is electronically transmitted and recorded in the control room. The transport line then passes on to a diverter valve (TA-8) that splits the 3 in. return line into two 3 in. lines. Each 3 in. line travels to a return jet (JET-NCC-505-1 or -2) that provides the motive force for the returning air. Air exiting from these jets passes into two return lines (4"-TAAB-1803 or 4"-TAAB-1806) that cross the third-level corridor and pass through the east wall of the calciner cell and into the top of the calciner vessel. The position of the diverter valve (TA-8) determines which of the two return lines is in operation and which is held in standby. The portions of the return lines that cross the third-level corridor are shielded with lead shot. The airflow to the operating transport air jet is set at a constant rate by adjusting rotameters (FI-505-1-1 or FI-505-2-1) located in the fluidizing air heater room (316).

The transport airflow rate is first monitored in the preheater room (316) via a flowmeter (FE-205-2). A low-flow alarm (F205-2C LO) activates at 20 scfm. The flow rate is again monitored in the return jet cubicle (222) via another flowmeter (FE-105-40). The low-flow alarm (F105-40C) is set to activate at 32 scfm. Fluidizing air pressure is first monitored just downstream of the flow control valve (FV-205-2) in the preheater room via PT-205-4. P205-4C LO and HI alarms are set at 10.75 psia and 12.0 psia, respectively. Pressure is monitored again in the calciner cell via PT-105-11. P105-11C LO and HI alarms are set at 10 psia and 11 psia, respectively. Pressure readings are taken again at the solids storage cyclone and in the return line leaving the cyclone. The pressure in the return line is taken for the last time just as the line enters the return jet cubicle (PT-105-10). A high-pressure alarm (P105-10C HI) sounds at pressures > 12 psia. Temperature alarms are discussed in the next subsection, which details the heating system.

A decontamination line (1"-DCAF-4373) and block valves are also provided to help decontaminate the internal surfaces of the line in preparation for direct maintenance. All decontamination solutions from the transport air return lines drain to 2"-PLAD-4232. The floor drain from the return jet cubicle change room drains to 2"-PLAD-4244. These solutions eventually drain to the hot sump tanks where they are recycled as feed to the calciner.

2.5.1.3.16 Transport Air Heater—In addition to heat tracing the transport and return lines with a 150 lb steamline, the transport air is heated to help prevent condensation of moisture introduced from the calciner cyclone. This is accomplished by passing the transport air through the transport air heater (HE-NCO-331) located in the cell access corridor. Sufficient heat (22,000 Btu/h) is added with this air and steam heat exchanger to maintain the transport air temperature above 167°F (75°C) throughout the transport system or approximately 59°F (15°C) above the estimated maximum dewpoint. The steam control valve (HS-331-1) for the heat exchanger is adjusted manually. The heat exchanger is insulated and sized for a maximum anticipated airflow of 200 scfm. The heater is fabricated of stainless steel and is designed for a shell pressure of about 150 psig and a tube pressure of 15 psig.

Air temperature control is maintained by manually adjusting the steam flow to the transport air heater (HE-NCO-331) and by monitoring the temperature of the line skin at the following points:

1. Just before leaving the calciner cell (TE-105-13), at which point the low alarm (T105-13C LO) is set at 110°F (43°C)

2. At the calcined solid storage bins

3. On the transport and return lines

4. On the return line in the return jet cubicle (TE-105-12), at which point the low alarm (T105-12C LO) is set at 120°F (49°C).

These alarms and monitoring points allow adequate lead time to adjust the air heater (HE-NCO-331).

2.5.1.3.17 Transport Air Jets**—**An air-operated jet (JET-NCC-505-1 or -2) is located in each transport line to help pull air through the transport air return line. The motive force created by the jets is necessary to alter the pressure balance on the system and to overcome the added resistance created by high solids loading in the transport line. The jets are operated from the fluidizing air preheater room by manually valving high-pressure plant air through a rotameter (FI-505-1-1 or FI-505-2-1). Air purges are maintained on both jets at all times to prevent calcine buildup in the jet throat. The jet that is in service is operated on a continuous basis. Manually operated block valves (TA-505-1-1 and TA-505-2-1) are located in the return line on the discharge side of each jet. These block valves are used with blast air and decontamination solutions to clear solids restrictions. Drainlines are also provided to clear the decontamination solution from the line.

2.5.1.4 Calciner Off-Gas Cleanup System. The off-gas system performs three main functions in the NWCF:

1. Maintaining a vacuum on the process and discharge fluidizing air, purge and sparge air, and vessel vent air

2. Removing radioactive materials (including volatile ruthenium compounds) from the POG prior to discharge to the APS

3. Controlling the humidity of the off-gas so that water from the feed and water introduced as purges, etc., does not damage HEPA filters.

The off-gas system employs a series of components to collect progressively smaller particles.

Initially, a cyclone (VES-NCC-107) removes the larger particles and adds them to the product transport line via 2”-TAAB-1802. A wet scrubbing system, including demisting equipment and de-entrainment separators, removes particles that pass by the cyclone. Particulate matter collected in the wet scrubbing system is dissolved and recycled back to the feed system for recalcination. The recycle of the scrubbing solution reduces the net processing rate of the calciner by about 15%. After passing through the wet scrubbing system, the off-gas can be reheated before entering the silica gel adsorber beds that collect very small quantities of unburned hydrocarbons and volatile ruthenium compounds. An additional mist eliminator is included downstream of the ruthenium adsorbers for moisture and particulate removal. Next, the off-gas passes through another heater and through parallel filter plenums, each containing one HEPA-grade prefilter and two HEPA filters. Normally, two filter plenums are operable with intact HEPA filters during all calcine operations and when using blowers (BLO-NCC-243-1 and -2) to maintain the system vacuum. During filter change-out, when the calciner operations are shut down, or during HLLWE operations, it is acceptable to operate on one filter plenum. After passing through the final HEPA filters, the off-gas enters the off-gas blowers that maintain the vacuum required in the calciner vessel.

Instrument and sparge air from NWCF vessels is discharged to the POG line between the ruthenium adsorbers and the mist collector (VES-NCC-116) through a vent condenser (HE-NCC-336). Vacuum on the system is maintained by the off-gas blowers. The vacuum is monitored by a pressure-indicating alarm (P122-1C LO) on the nonfluoride hot sump tank (VES-NCC-122). The alarm sounds if the vacuum drops to 5 in. of W.C. vacuum. The normal vacuum is 10 in. of W.C. vacuum. P122-1C adjusts the position of the flow control valve (PV-122-1) and thereby controls the vacuum in the vent system.

2.5.1.5 Process Shutdown. Process shutdowns occur because of scheduled maintenance or unscheduled failures. The length of a shutdown depends on the amount of time needed to complete repairs. Short-term shutdown requires a static bed condition. The bed is heated and maintained in the fluidized state. Extended or "long-term" shutdown periods are typically associated with scheduled maintenance activities and usually require the removal of the bed material.

2.5.1.6 Process Control

2.5.1.6.1 Process Control and Monitoring Features—Process control is maintained from the NWCF control room (438), which is located at grade level. The calcination process, the calciner area ventilation system, and radiological safety information are controlled and monitored from this area.

2.5.1.6.2 Rapid Shutdown System—The RSS provides a means of ensuring that the calcination and evaporator processes are safely shut down if the process exceeds important operating parameters. A secondary purpose of the RSS is to provide a single control button that an operator can activate given the need for an immediate and complete process shutdown. However, under normal and most abnormal conditions, process shutdowns are strictly manual operations carried out in accordance with the written procedures and the RSS is not used.

Table 2-31 summarizes the RSS activation conditions and responses. As shown in Table 2-31, there are seven RSS response functions. However, the responding combination of one or more of these functions depends on the initiating conditions.

The waste feed shutdown portion of this system simultaneously stops the flow of waste feed to the calciner through all four feedlines. Sequentially, it purges each line with water for 10 seconds, and initiates and maintains an air purge to each feedline until the shutdown system is reset and waste feed flow is resumed. A simultaneous water purge on all four feedlines is avoided because of the possible pressurization problems associated with the sudden vaporization of the purge water. Thus, 40 seconds after experiencing an RSS shutdown condition, flow through all four feedlines is terminated, each line is under a continuous air purge, and the fuel and oxygen flows are also shut off. The air purge continues until the initiating condition is corrected.

The RSS response signal can initiate fuel and oxygen shutdown under specific conditions. This shutdown closes two valves (FV-105-6 and FV-105-14 for fuel line ¼"-KRNB-1840) in each fuel line, initiates an air purge to each fuel line, and closes two valves (FV-105-10 and FV-105-18 for oxygen line ¾"-ONAE-1844) in each oxygen supply line. A continuous air purge is maintained on each oxygen supply line via lines ½"-LAAF-3893 through -3896. Thus, as soon as the oxygen flow is terminated, the oxygen lines are under air purge. Air purges are necessary to help minimize possible plugging problems in the fuel nozzles.

Table 2-31. NWCF rapid shutdown system functions.

Function Initiated by Rapid Shutdown System (RSS)

Conditions That Will Activate RSS	Waste Feed Shutoff	Oxygen and Fuel Shutoff	Fluidizing Air Blower Shutoff	Fluidizing Air Heater Shutoff	Quench Tower Emergency Cooling	Off-C S
HIHI calciner bed temperature	Yes	Yes	No	Yes	No	
LOLO calciner bed temperature	Yes	Yes	No	No	No	
LOLO oxygen supply pressure	Yes	Yes	No	No	No	
LOLO fluidizing airflow	Yes	Yes	No	Yes	No	
LOLO calciner cell ventilation flow and high calciner cell temperature	Yes	Yes	No	Yes	No	
Loss of vacuum in off-gas cleanup train	Yes	Yes	Yes	Yes	No	
HIHI quench tower off-gas temperature	Yes	Yes	No	Yes	Yes	
HIHI condensate level in off-gas blower intercoolers	Yes	Yes	Yes	Yes	No	
Manual activation of emergency shutdown button	Yes	Yes	Yes	Yes	No	
Seismic event	Yes	Yes	Yes	Yes	No	
HIHI fluidizing air temperature	No	No	No	Yes	No	
HIHI HLLWE flash column temperature	No	No	No	No	No	

HIHI - means second level of high alarm.
LOLO - means second level of low alarm.

When the conditions that can initiate a fluidizing air blower shutdown occur, an output signal is sent via the power relay to the primary fluidizing air blower (BLO-NCO-205-1) and the standby fluidizing air blower (BLO-NCO-205-2). As soon as the initiating conditions are cleared, the fluidizing air blowers can be started upon operator command. Therefore, procedures do not allow restart until the initiating conditions have been corrected and the trip has been cleared.

When the conditions that can initiate a fluidizing air heater shutdown occur, an output signal is sent via the power relay to de-energize the two fluidizing air heaters (HTR-NCO-305-1 and -2). The power remains off until the initiating conditions are corrected and the trip has been cleared. It is also possible to have an individual heater shut down because of high heater-element temperatures, but this function is independent of the RSS response functions.

The only initiating condition that activates the emergency quench tower cooling is HIHI off-gas temperature. This signal (T109-1C) opens a valve (TV-109-1) to provide treated water via the quench tower decontamination spray nozzles. Unlike the other RSS response functions, the quench tower cooling system does not have an interlock relay system. Cooling water continues to flow until the off-gas temperature drops below the T109-1C HIHI alarm setpoint or a manual override valve (TW-109-3) is closed. If no action is taken to stop the flow of treated water, and off-gas still exceeds the limits set for T109-1C, then it is possible to exceed the volume of the scrub hold tank (VES-NCC-108). This causes the scrub hold tank liquid-level instrument to alarm, and if no corrective action is taken, the treated water overflows to the fluoride hot sump tank (VES-NCC-119).

The off-gas blower shutdown system de-energizes the primary and standby off-gas blowers (BLO-NCC-243-1 and -2) and energizes the auxiliary off-gas blower.

The initiating condition that activates the RSS HLLWE steam shutoff is a HIHI temperature alarm on the flash column (T150-1C through -10C). This signal causes the steam supply valve (F350-1C/FV-350-1) to close.

The preceding paragraphs identify the RSS responses. The following paragraphs detail the conditions that activate RSS responses (see Table 2-31).

The first initiating condition listed in Table 2-31 is high calciner bed temperature. The main consequences of high calciner bed temperature are vessel damage caused by carburization and reduction of the vessel's structural strength. The calciner bed temperature is monitored by a temperature rake that contains five TCs. The temperature signals (TE-105-1-1, -2, -4, -5, -6) are averaged and transmitted to another temperature instrument (T105-1C). This signal also is used to activate alarms for high and low bed temperatures. An alarm (T105-1C HI) sounds whenever the bed temperature exceeds 1157°F (625°C). No automatic corrective instrument is activated by this signal; thus, corrective action is an operator function, which is the preferred mode of operation. However, if the operator fails to act or takes the wrong corrective action and the bed temperature exceeds 650°C (1202°F), then the HIHI alarm activates the RSS.

The RSS also monitors the fluidizing air temperature. If the temperature reaches 1150°F (621°C), an alarm activates the RSS. The RSS responses are identified in Table 2-31.

The hazard associated with low bed temperatures is the possibility of dropping below the autoignition point of the fuel, which could result in the formation of an explosive concentration of hydrocarbon vapors inside the calciner vessel. The averaged bed temperature signal is used to activate the alarm (T105-1C LO) that signals when the bed temperature reaches 382°C (720°F). As for high bed temperature, the first and preferred form of corrective action is operator response. If such action fails and the bed temperature drops below 340°C (644°F), another alarm (T105-1C LOLO) activates the RSS. The combination of RSS responses for low bed temperature is shown in Table 2-31.

Oxygen pressure is detected via PT-105-21 in the second-level corridor to monitor the oxygen supply. Loss of oxygen to the fuel nozzles leads to inefficient combustion and above-bed burning, which are undesirable operating conditions. Therefore, whenever the oxygen pressure drops to 70 psig, an alarm (P105-21C LOLO) activates the RSS. This signal passes through a 0 to 10 minute delay timer before shutting off the fuel, oxygen, and waste feed flow to the calciner. The timer prevents spurious shutdowns from pressure spikes. However, before the automatic response occurs, the P105-21C LO alarm sounds when the oxygen pressure drops to 100 psig. This alarm allows an operator time to perform a manual shutdown or to correct the cause of low oxygen pressure.

Calcination without adequate fluidization could cause explosive pockets of unburned kerosene to form. These localized areas of high temperature could damage the calciner vessel. Operating under these abnormal conditions is prevented by monitoring the fluidizing airflow via FE-205-1. If the fluidizing airflow drops below 150 scfm, an airflow alarm (F205-1C LO) sounds to warn the operator. If the operator fails to respond to this alarm and the flow drops below 125 scfm, the F205-1C LOLO alarm activates the RSS, which responds by terminating the fuel, oxygen, waste feed flows and fluidizing air heater.

Low ventilation flow in the calciner area is avoided to prevent thermal damage to some process equipment and the shielded viewing windows and to provide adequate confinement. The calciner cell was selected as the monitoring point for the entire calciner area H&V system because of its concentration of contaminants, its potential heat output, and its sensitivity to changes in ventilation flow rates. Monitoring for abnormal flow involves the observation of two cell conditions: temperature and airflow. Monitoring airflow by itself could result in false alarms because it is possible to have significant momentary changes in airflow. If the low flow is maintained long enough to cause the cell temperature to rise, a true potential hazard exists. As is the case with the other initiating conditions for the RSS, alarms sound prior to RSS response, which gives the operator time to correct the abnormal condition or to perform a manual shutdown. TE-2214-1 senses the calciner cell temperature, and the signal from TT-2214-1 is monitored by T2214-1C, which is set to alarm HI at 120°F (49°C). The T2214-1C HIHI alarm is relayed to the RSS when the cell temperature reaches 160°F (71°C). The cell ventilation flow is detected by FE-2214-1; the signal from FT-2214-1 is monitored by F2214-1C; the F2214-1C LO alarm is set off at 2000 scfm. The F2214-1C LOLO alarm is set off when the flow drops to 1000 scfm. If the flow remains at or below 1000 scfm for 60 seconds or more, the signal is relayed to the RSS. If both the temperature and flow activating conditions are present, the RSS response is initiated.

Loss of vacuum in the POG cleanup train jeopardizes the confinement of the primary barrier and could produce poor fluidization in the calciner and cause pneumatic instrument probes to be flooded. There are four pressure-sensing points that must detect high pressure, which is a LOLO alarm. These instruments are calibrated to read positive values for vacuum (LOLO vacuum). All four LOLO alarm conditions must be received to initiate the proper RSS response. All four points are used to prevent inadvertent activation of this RSS response.

The first of these pressure taps (PT-105-1) is located on the top of the calciner vessel. If the vessel pressure increases, the P105-1C LO alarm is set off. If the pressure continues to increase, the P105-1C LOLO alarm is set off and relays a signal to the RSS. The second pressure-sensing instrument is located just upstream of the ruthenium adsorbers. If the P334-2C LOLO alarm is set off, a signal is relayed to the RSS. The third pressure instrument (P130-2C) is located just upstream of the process off-gas HEPA filter. If the P130-2C LOLO alarm is set off, a signal is relayed to the RSS. The fourth and last pressure instrument (P243-1C) is located upstream of the POG blowers. If the P243-1C LOLO is set off, a signal is relayed to start the standby blower and stop the operating blower. If the P243-1C LOLOLO alarm is set off, signals are relayed to the RSS and to start the auxiliary off-gas blower (BLO-NCC-242). As mentioned previously, the RSS does not respond until all four high-pressure instruments are on alarm.

POG temperatures of > 300°F (149°C) exiting from the quench tower could damage the off-gas cleanup equipment located downstream of this unit. This is because normal operating conditions do not require protection against thermal expansion beyond this temperature. Therefore, any time the off-gas temperatures exceed 300°F (149°C), action must be taken to cool the gases and eliminate the heat source. TE-109-1 monitors the off-gas exiting the quench tower, and this signal is sent to T109-1C via TT-109-1. The T109-1C HI alarm is set off when the off-gas temperature exceeds 200°F (93°C). The T109-1C HIHI alarm is set off and relays a signal to the RSS when the off-gas temperature exceeds 300°F (149°C). This signal initiates emergency quench tower cooling via the treated water line 1 ½"-TWNC-4064. Water continues to flow until the temperature drops below 300°F (149°C).

A high condensate level in the POG blower intercooler could, under abnormal conditions, cause some liquid to be sucked into the blowers and thereby significantly damage the blower impellers. To prevent this event, the condensate liquid level is monitored and connected to an alarm. If the liquid is not manually drained, the L143-1-1C HI alarm is set off and relays a signal to automatically open a valve (LV-143-1-1) that drains the condensate to the nonfluoride hot sump tank (VES-NCC-122). The L143-1-1C HIHI alarm and L143-2-1C HIHI alarm activate the RSS. The RSS shuts down the process and de-energizes the off-gas blowers while starting the auxiliary off-gas blower.

A seismic event (0.02 g) will trigger an RSS trip. To prevent spurious trips, a signal from each of two separate seismic switches (XSH023-1C and XSH023-2C) must be activated. Each seismic switch is wired to the control room on redundant circuits (one normally open and one normally closed) to maintain fail-safe activation on either open wires or shorted wires.

A high temperature in the HLLWE could cause a runaway nitrated-organic reaction to occur if a separate organic phase were present in the evaporator. Temperature instruments (T-150-1C, -2C, -3C, -4C, -5C, -6C, -7C, -8C, -9C, and -10C) indicate the temperature in the HLLWE. The RSS automatically terminates steam flow to the HLLWE reboiler if a HIHI temperature is achieved in the HLLWE.

The last method of initiating conditions for the RSS is manual activation of the shutdown button. Such action is taken only when operating conditions do not allow enough time for a manual shutdown, such as during a plant evacuation.

2.5.2 Feed Composition

The radioactive waste solutions that remain to be processed in the NWCF are mostly sodium waste.

Typical chemical compositions for the sodium waste are listed in Table 2-32 and typical radiochemical compositions for sodium waste are listed in Table 2-33.

2.5.3 Process Chemistry and Physical Chemical Principles

The primary reactions taking place in the calcination process are (1) the decomposition of nitric acid, (2) the evaporation of water, (3) the conversion of the aluminum and metal nitrates to the metal oxides, (4) the conversion of zirconium fluoride to zirconium oxide, and (5) the formation of calcium fluoride. The fission products are converted to oxides if the nitrate is unstable at the calcination temperature. Cesium and strontium probably remain predominantly as nitrates, as does sodium nitrate, and possibly calcium nitrate if it is present in excess of the amount that reacts with the fluoride.

Table 2-32. Typical chemical composition of sodium-bearing waste to be processed in the NWCF (molar).

Component	Sodium Waste
H+	1.2
NO_3	4.6
F	0.05
Al	0.6
Zr	0.005
B	0.01
Cd	0.001
SO_4	0.06
Na	1.6
K	0.2
Fe	0.02
Cr	0.003
Ca	0.04

Table 2-33. Typical radiochemical composition of sodium-bearing waste (mCi/L).

Component	Sodium Waste
^{3}H	0.03
^{60}Co	0.2
^{90}Sr	30.0
^{106}Ru	0.15
^{125}Sb	0.2
^{134}Cs	0.3
^{137}Cs	45.0
^{144}Ce	2.0
^{154}Eu	0.1
^{155}Eu	0.2
U (mg/L)	70.0
Np (mg/L)	0.002
Pu (mg/L)	0.8

NOTE: The radiochemical compositions have not been corrected for decay.

The simplified chemical reactions taking place in the calcination process follow:

1. $2Al(NO_3)_3 \rightarrow Al_2O_3 + 6NO_2 + 3/2\ O_2$
2. $2HNO_3 \rightarrow 2NO_2 + ½\ O_2 + H_2O$
3. $NO_2 \rightarrow NO + ½\ O_2$
4. Metal nitrates → Metal nitrates/oxides
5. $ZrF_4 + 2H_2O \rightarrow ZrO_2 + 4HF$
6. $2HF + Ca(NO_3)_2 \rightarrow CaF_2 + 2HNO_3$
7. Fission product nitrates → Fission product nitrates/oxides.

Special reactions that are peculiar to blended waste are described in the following subsections.

2.5.3.1 Adding Calcium Nitrate to Waste. To prevent corrosion of stainless steel off-gas equipment during calcination of fluoride-bearing waste, calcium is added (as calcium nitrate) prior to calcination to retain the fluoride in the calcined solids. The calcium reacts with fluoride in the feed solution to form a gelatinous precipitate of calcium fluorozirconate ($CaZrF_6$). This gelatinous precipitate remains suspended in the feed solution and during the calcination, at 500°C (932°F), reacts to form calcium fluoride, according to the reaction

$$CaZrF_6 + 2Ca^{++} + O_2 \rightarrow 3CaF_2 + ZrO_2.$$

The calcium fluoride is thermally stable at the calcination temperature (500°C [932°F]). The mole ratio of calcium to fluoride for straight zirconium fluoride waste in the feed solution is 0.55, which provides 10% more than the amount required to react chemically with all of the fluoride. The calcium-to-fluoride mole ratio for sodium waste blends is 0.70, which provides for better particle size control.[26]

2.5.3.2 Blending of Zirconium Fluoride Waste and Sodium-Bearing Waste. Calcination of the sodium-bearing waste, which contains up to 2 M sodium nitrate, is difficult because the solid sodium nitrate, which is molten at 500°C (932°F), causes agglomerates to form in the fluidized bed. To prevent agglomeration, sodium-bearing waste is blended during calcination with zirconium fluoride waste to form cryolite (Na_3AlF_6). The resulting calcine is thermally stable at the calcination temperature of 500°C (932°F).[27] The reaction is assumed to be

$$3NaNO_3 + ZrF_4 + Al(NO_3)_3 + 2HF \rightarrow Na_3AlF_6 + ZrO_2 + 6NO_2 + 2H_2O + O_2.$$

2.5.3.3 Adding Aluminum Nitrate to Sodium Waste. Historically, sodium waste has been processed as a blend with zirconium waste in the calciner because sodium waste by itself is difficult to calcine. With the phaseout of fuel reprocessing, zirconium waste is no longer generated. Sodium waste contains sodium nitrate in sufficient concentrations to make calcination of this waste in a fluidized bed difficult. Sodium nitrate exists in the molten-undecomposed state over a wide temperature range (300° to 850°C [572° to 1562°F]); thus, during calcination of waste containing sodium nitrate, fluidized-bed particles tend to agglomerate. To overcome this problem, aluminum nitrate is blended with sodium waste to lower the decomposition temperature of sodium nitrate and to combine with sodium at a low temperature to form a compound that is stable at, and has a melting point above, the calcination temperature. When sodium waste is calcined at higher temperatures (500° to 600°C [932° to 1112°F]) more sodium nitrate decomposes, and less aluminum nitrate is needed to calcine the sodium waste without agglomeration.

2.5.4 Product Properties

The typical product resulting from calcination of high-level Tank Farm waste consists of granular particles that are nearly spherical. The particle diameter of the product from the bed is generally in the range of 0.2 to 0.6 mm, but the diameter may vary from about 0.1 to 1.5 mm. It is free-flowing and readily transported pneumatically through pipelines. Most of the particles that leave the calciner vessel in the off-gas are removed by the primary cyclone and routed to the storage bins along with the calciner bed material. The chemical and radiochemical composition and heat generation rate of the calcined product vary significantly, depending on the type of waste. Other properties vary to a lesser extent. Typical properties of calcined products that have been produced at the INTEC are shown in Table 2-34.

2.5.4.1 Attrition Resistance. Product attrition occurs mostly as a breaking off of small irregularly shaped particles from the outer portion of granules in the fluidized bed.[28] To compare the relative attrition resistance of various calciner products generated under different conditions, a standard empirical test for attrition resistance index was developed.[29] The attrition resistance index is the percentage of the original material that remains unchanged in size after the test. A low attrition index indicates that the fluidized-bed height may be difficult to maintain at the desired level because of the excessive production of fine particles, whereas a high attrition index suggests that the particle diameter may become too large. In actual practice, the particle size is controlled by adjusting the nozzle air velocity, by blending different waste, and by calcining one type of waste for a short time and then another.

2.5.4.2 Product Size. The mass mean particle diameter (mmpd) of calciner product is controllable within the desirable range of 0.20 to 0.60 mm. The average particle size of the product is influenced by a complex mechanism of particle growth and attrition.

When the mmpd of the product in a bed becomes significantly larger than 0.6 mm, adequate fluidizing velocity cannot be maintained. An mmpd smaller than 0.20 mm results in excessive elutriation of bed material, which in turn can deplete the bed and expose the feed nozzles. At the NWCF, fines elutriated from the calcination vessel and captured by the calciner cyclone are combined with product on its way to solids storage, resulting in a stored material somewhat finer than bed material.

2.5.5 Effects of Operating Variables on Calcination Process

The effects of operating variables on the calcination process and on calciner product properties have been identified so that positive control of the NWCF can be ensured. The independent calcination variables over which control may be exercised during operation of the NWCF include the following:

1. Superficial fluidizing velocity
2. Bed temperature (normally operated at 500° to 600°C [932° to 1112°F])
3. Waste feed rate
4. Fuel nozzle oxygen-to-fuel ratio

Table 2-34. Typical properties of various types of calcine.

Type of Calcine	Aluminum Calcine[a]			Zirconium Calcine			Zirc/Sodium Blend			Fluorinel Calcine		
Description of Property	Typ	Min	Max	Typ	Min	Max	Typ	Min	Max	Typ	Min	M
Physical Properties												
Product bulk density (g/cm^3)	1.0	0.9	1.1	1.3	1.1	1.5	1.5	1.4	1.6	1.6	1.5	1.
Thermal conductivity (W/m-°C)	0.1	0.1	0.2	0.30	0.2	0.4	0.3	0.2	0.4	0.3	0.2	0.
Mass mean particle diameter (mmpd)	0.3	0.2	0.4	0.30	0.2	0.5	0.3	0.2	0.6	0.3	0.2	0.
Heat generation rate (W/m^3)	100	80	200	100	80	150	90	70	150	100	80	15
Attrition index (%)	60	50	70	15	10	20	50	40	60	50	40	60
Volume reduction factor	14	10	20	8	6	9	8	7	9	7	6	8
Crystalline structure	Amorphous			CaF_2, ZrO_2			CaF_2, ZrO_2, $NaNO_3$			CaF_2, ZrO_2		
Descriptive color	White			Yellow-Brown			Yellow-Brown			Yellow-Brown		
Chemical Composition (wt%)												
Al_2O_3	89	84	91	15	14	16	16	14	16	7	6	8
ZrO_2	1	0	2	24	23	26	21	19	21	22	19	25
CaF_2	2	0	4	52	51	54	43	41	44	50	47	53
CaO_2	1	0	2	4	1	5	0.1	0	0.5	3	3	9
$CaSO_4$	0.5	0	1				0.4	0	1			
CdO									0.1	4.5	3	7
$CdSO_4$										8	4	9
B_2O_3	0.5	0	1	3.5	3	4	3	2	3	3.5	3	4
$NaNO_3$	4	3	5	1	0	2	14	10	15	1	0	2
KNO_3	0.5	0	1	0.2	0	0.4	2	1	3	0.5	0	1
Fe_2O_3	1.5	0	2	0.3	0.1	0.7	0.5	0	1	0.5	0	1
Cr_2O_3							0.1	0	0.2			
Gd_2O_3												
Ni_2O_3							0.1	0	0.2			

Table 2-34. (continued).

Type of Calcine	Aluminum Calcine[a]			Zirconium Calcine			Zirc/Sodium Blend			Fluorinel Calcine		
Description of Property	Typ	Min	Max	Typ	Min	Max	Typ	Min	Max	Typ	Min	M
Long-lived radionuclides												
^{137}Cs (Ci/kg)	15	10	25	6	3	11	5	2	10	b	b	b
^{90}Sr (Ci/kg)	15	10	21	6	2	10	5	2	10	b	b	b
^{239}Pu (mCi/kg)	4	2	7	5	2	8	5	2	8	b	b	b

a. The physical properties of aluminum calcine are based on the Waste Calcining Facility operation. Aluminum calcine in the New Waste Calcining Facility will have
0.35 mm).

b. The radionuclide content of fluorinel calcine is classified.[30]

5. Waste nozzle air-to-liquid ratio

6. Feed blending.

The general effects of operating variables on the calcination process are summarized in Table 2-35

2.5.5.1 Independent Operating Variables.

2.5.5.1.1 Superficial Fluidizing Velocity—Superficial fluidizing velocity is defined as the velocity of the fluidizing gas on the basis of the empty cross-section of the calciner at the bed temperature and vessel pressure. The superficial fluidizing velocity affects the degree of mixing in the bed, intrabed heat transfer, the rate of bed attrition, and the rate of elutriation of material by the off-gas. The fluidizing velocity is selected to provide quality fluidization and to minimize solids elutriation, and depends both on bed particle size and density.

Low velocities reduce solids elutriation but may result in bed caking around feed nozzles and calcine sintering around fuel nozzles caused by inadequate fluidization. Higher velocities increase the solids elutriation rate. The elutriation rate must be kept below the production rate or bed depletion results.

The fluidizing velocity also affects particle attrition but to a lesser extent than the effects of high-velocity feed atomizing air and combustion gases. Heat transfer rates increase as a bed becomes fluidized, reach a maximum at some velocity above the incipient fluidizing velocity, and then decrease as the bed expands further.

Absolute values for the effects of fluidizing velocity on heat transfer rates, solids elutriation rates, and the limit of adequate fluidization have not been established because of the difficulty in isolating the effect of this single variable.

2.5.5.1.2 Bed Temperature—Bed temperature affects the properties of the calcine. The temperature profile throughout the bed can be used to indicate the quality of fluidization.

Increased bed temperatures normally increase the product porosity, reduce nitrate and water content, and favor retention of ruthenium in the product.

Bed temperatures in a well-fluidized bed are uniform within ±10°C except in the narrow zone in which atomized feed is entering. Within the spray cone formed by the atomized feed, temperatures down to 100°C (212°F) have been measured. This temperature depression disappears 12 to 15 in. from the nozzle.[31] Wide temperature gradients in a bed, other than in the feed nozzle zone, indicate a state of inadequate fluidization and, hence, poor heat transfer. This can be caused by excessive growth of the bed particles or by low fluidizing velocities.

2.5.5.1.3 Waste Feed Rate—The NWCF was designed for a nominal feed rate of 214 gph. However, higher feed rates may be employed because, with excellent heat transfer in the bed, feed flux density in the reaction zone is not a limiting factor on capacity. The feed rates of some solutions are limited to prevent exceeding NO_x limits for releases out of the INTEC Main Stack. The minimum practical feed rate to the calciner is the rate at which the salts in the feed replace the bed material lost through elutriation with no other product removal. At lower feed rates, gradual bed depletion would lead eventually to nozzle exposure, spray drying, and the formation of large quantities of submicron fines that are particularly difficult to remove from the off-gas.

Table 2-35. General effect of increasing operating variables on calcination process.

Operating Variable	Effect of Increasing Operating Variable			
		Primary Effect		Seconda
Fluidizing velocity	1.	May decrease heat transfer rate.	1.	May decrease
	2.	Slight increase in bed attrition. Increased product elutriation.	2.	Small bed-part
Bed temperature	1.	Increased product porosity.	1.	Reduced produ
	2.	Reduced nitrate and water contents of product.		
	3.	Favors high retention of ruthenium in product.		
Waste nozzle air-to-liquid-volume ratio (feed rate held constant)	1.	Increased bed attrition.	1.	Smaller bed-pa
	2.	Smaller feed droplets.	2.	Smaller bed-pa elutriation.
Waste feed rate	1.	Decreased residence time of production bed.	1.	Favorable to pr particle size.
Fuel nozzle oxygen-to-fuel ratio	1.	Increased combustion efficiency.	1.	May increase p
	2.	Increased flame temperature.		

The dissolved-solids concentration determines the total solids output of the calciner for any particular feed rate and significantly affects the intraparticle porosity and bulk density of calciner product. Low-porosity product results from use of a combination of low bed temperature and dilute feed. Limited additional control over the calcination process is afforded by adjusting the rate at which scrubbing solution is recycled to the feed tanks. It is desirable to minimize this rate. Low recycle rates allow more fresh waste to be processed through the calciner. Lowering the rate, however, increases the undissolved-solids concentrations in the scrubbing solution.

2.5.5.1.4 Atomizing-Air-to-Waste Feed—The rate at which atomizing air is supplied to the pneumatic feed nozzles of a calciner governs the degree of feed atomization and significantly affects the attrition rate of particles in a fluidized bed. These factors, in turn, influence the bed-particle size.

The degree of feed atomization is generally characterized by the liquid-to-air volume ratio for the feed nozzle (NAR). Operation at a high NAR value results in a finely atomized feed spray and an accelerated attrition rate, both of which tend to decrease the size of the bed particles. Decreasing the NAR value results in larger feed droplets, less bed-particle attrition, and a corresponding growth of bed particles.

The relative rates of particle growth or particle reduction and the stabilization of the size of a particle for a particular NAR value depend primarily on how easily the bed material can be broken. The proper value of NAR for particle size stabilization also is dependent upon the nozzle design. The slow changes in particle size resulting from NAR variance indicate that the NAR can be used as an effective method for process control with minimum probability of completely upsetting the process.

2.5.5.1.5 Oxygen-to-Fuel Ratio—The ratio of oxygen to fuel in the fuel nozzle governs both combustion efficiency and flame temperature during IBC. Adequate combustion is desired to minimize unburned hydrocarbons and particulate carbon in the calciner off-gas. The flame temperature increases with increasing combustion efficiency and can cause bed sintering at too high of a flame temperature.

Oxygen is used to atomize the fuel, which results in a more intimate mixture of fuel droplets and oxygen and, thus, reduces the amount of fluidizing and atomizing oxygen required for IBC.[31] Atomizing the fuel with oxygen instead of air also results in a lower minimum stable combustion temperature and decreases the chances of above-bed burning (burning in the vapor space above the fluidized bed).

2.5.5.2 Dependent Operating Variables.

2.5.5.2.1 Attrition and Particle Growth of Bed Material—Constant generation of additional seed-size material is necessary in the fluidized-bed calcination process to maintain a stable average bed-particle size. These seeds are generated by attrition of the bed by the feed atomizing air, the flame jet, and the fluidizing gas. Seeds automatically provided by bed attrition can be supplemented by introducing a suitably sized inert material into the bed.[32] Attrition of bed material is undesirable to the extent that it results in formation of material that is too small to function as seeds and is rapidly elutriated from a bed. Attrition is significantly influenced by the physical nature of the bed material as well as by the rate of introduction of nozzle atomizing air and of fluidizing air.

2.5.5.2.2 Elutriation of Bed Particles—Elutriation of fines material from a fluidized-bed calciner is affected by all of the independent operating variables to varying degrees. This makes quantitative evaluation of the individual effects difficult. Elutriation of material is undesirable because essentially all particulate matter must be separated from the off-gas. In extreme cases, elutriation can lead to bed depletion, and spray drying can result if the nozzles are exposed. This is undesirable because of the small size of the spray-dried particles and the resulting increased load on the off-gas decontamination system.

The rate of elutriation of fines from a calcination vessel increases sharply with an increase in the superficial fluidizing gas velocity and with a decrease in the size of bed particles. Entrainment rates will increase with decreases in vessel freeboard, in fines density, and in fluid (air) viscosity. Vessel geometry also affects entrainment rates. The calciner vessel (VES-NCC-105) has an expanded upper section and two rows of deflection plates to help minimize the particle carryover problem.

2.5.5.2.3 Combustion Reaction—In-bed fuel combustion is a complex function that depends on the quality of atomizing provided by the fuel nozzle and the oxygen-to-fuel ratio. The reaction occurs in a localized flame zone near the fuel nozzle and is affected by variables such as bed temperature and nitrate concentration of the waste feed.

The minimum operating temperature for stable burning varies with the type of waste. Initial pilot plant tests indicated that the minimum operating temperature for stable IBC was 392°C (738°F) for aluminum waste and 460°C (860°F) for zirconium waste. Later tests have shown that operation is possible at a lower temperature by using pure oxygen to atomize the fuel. Zirconium waste has been calcined at 420°C (788°F) with no above-bed burning by atomizing the fuel with oxygen instead of air.

2.5.6 Support Systems

2.5.6.1 Sampling and Analytical Requirements. Process operation at the NWCF is monitored routinely by sampling and analyzing the contents of major vessels, as well as by observing instrument responses. Liquid sampling stations are installed in the gas and liquid sample cell (320) to sample the contents of (1) the blend and hold tanks, (2) the calciner during decontamination, (3) the scrubbing solution hold tank, (4) the decontamination solution tanks, (5) condensate from the mist eliminator, and (6) the hot sump tanks. A solids sampling station is installed in the flowmeter cubicle (314) to sample the calciner bed. A 2 in. diameter transfer line is provided to pneumatically transfer sample rabbits from the calciner solids sampler to the gas and liquid sample cell, if necessary. Solids samples are routinely analyzed for particle size and bulk density in the flowmeter cubicle. Solids samples can manually be obtained from the filters leached in the filter leaching tank.

The sampling stations provide a sufficient quantity of gas, liquid, or solids to be representative of the contents of the vessel or pipe being sampled. Samplers and sample stations are capable of reliable remote operation and are easy to maintain. The sampling stations are within heavily shielded cell and cubicle walls to prevent radiation exposure to personnel. The stations are leak-resistant to minimize the spread of contamination within the cell or cubicle.

Samples are taken remotely and shipped by the pneumatic transfer system (PTS) to the RAL. The RAL contains remote handling equipment for receiving, storing, and analyzing radioactive and hazardous samples. If the PTS breaks down, the sample is remotely inserted into a shielded cask and transported to the RAL.

Samples from leached filters are bagged and transported to the RAL for analysis.

2.5.6.1.1 Liquid Sampler—Air-jet-type samplers (JET-NCC-500, -510, -520, and -530) are used to sample liquids in the NWCF. All liquid samplers are provided with an air bleed into the suction leg of the sampler just above the tank nozzle to assist the vacuum jet in raising the process solutions from the tank being sampled. The air bleed forms bubbles in the process solution, decreasing the solution density and reducing the suction lift required. Each sample bottle (15 mL) is fitted with a screw cap that has a diaphragm in the cap top. The sample bottle is connected to the sampling circuit with remote manipulators. The bottles are raised by an air ram, which results in the piercing of the diaphragm on the sample bottle top with a hypodermic needle sampler assembly. One needle of the sampler assembly is the sample supply line; the other needle is the sample return line. The diaphragm provides a bottle seal both during and after sampling.

Each sample station is equipped with a sample line flushing system. Air, water, or steam can be applied to the sample lines to clear obstructions.

2.5.6.1.2 Solids Sampler—The solids sampler (located in the flowmeter valve cubicle) removes about 15 cm^3 of solids from the lower section of the calciner vessel. Sampling is accomplished by pneumatically moving the calcined solids from the calciner vessel to a small cyclone sample station through a ½ in. stainless steel line. A vacuum is applied to the sample station and sample supply line with an air-operated vacuum jet (JET-NCC-550). Solids collected in the sample station cyclone are transferred to a sample bottle. Excess solids in the sample cyclone are returned to the calciner vessel through the sample jet and sample return line. Equipment for determining calcine particle-size distribution is located in the cell. If further analysis is required, the samples are pneumatically transferred to the gas and liquid sample cell and from there to the RAL.

2.5.6.2 Process Decontamination and Solution Disposal. The INTEC philosophy of direct maintenance for highly reliable equipment in low radioactive fields and remote maintenance for higher radioactivity areas and equipment items having high-maintenance potential is incorporated into the design of the NWCF. Direct maintenance is performed only after remote and direct decontamination efforts are no longer effective. Provisions have been made for remote decontamination (internal and external) of equipment and piping normally contaminated by radioactive materials. Decontamination solutions are mixed and heated to the correct concentrations and temperatures in the decontamination solution tank (VES-NCM-117) and the decontamination nitric acid tank (VES-NCM-118). These tanks are located in the decontamination solution makeup room (429).

2.5.6.2.1 Process Cell and Cubicle Decontamination—The following calciner area process cells and cubicles are equipped with ceiling or wall-mounted spray decontamination headers: (1) the calciner cell, (2) the hot sump tank cell, (3) the crane maintenance and transfer area, (4) the filter cell, (5) the adsorber cell, (6) the off-gas cell, (7) the blend and hold cell, (8) the valve cubicle, (9) the flowmeter cubicle, and (10) the liquid sample cell. These sprays are used to decontaminate the cell walls, floor, and external surfaces of all process equipment and piping prior to personnel entry. Each process area contains sufficient nozzles to cover all surfaces with a homogeneous spray. The piping, headers, and nozzles do not block or interfere with any portion of the access hatch opening. Normal H&V flow to a given cell is significantly reduced during decontamination to minimize mist carryover into the exhaust duct. A mist eliminator pad is also provided over the exhaust outlet to further minimize this problem.

The main decontamination headers are located in the corridor with valved subheaders entering each cell. The cell decontamination hose connections, located near the inside of each cell door, connect to the cell equipment header. The hose connections are used to supply solutions to handheld sprays.

2.5.6.2.2 Process Hot Sump Tanks and Waste Transfer Lines—All solutions from NWCF process equipment, cells, and cubicles are drained by gravity or transferred by jet to one of two hot sump tanks. A separate system (i.e., the decontamination collection tank [VES-NCD-129] and the decontamination holdup tank [VES-NCD-123]) collects waste solutions that drain from the decontamination area including the filter handling cell in which the filter-leach system is located. Solutions from decontamination area systems may be transferred to the hot sump tanks. Each cell and each cubicle contains at least one floor drain located near the wall opposite the process area access door.

The cell floors slope to a drain gutter, and the gutter slopes to the floor drain. The final disposal of this waste is through waste transfer lines to the NWCF blend and hold tanks, the PEW evaporator feed collection tank, or the waste storage tanks.

Waste from the hot sump tanks is transferred by either pump or one of two steam jets. Each jet discharge line contains a check valve before the juncture of the two lines. Waste solution can be transferred from either of these tanks to the blend and hold cell for calcination. Dilute solutions can be transferred to the INTEC PEW evaporator for concentration. This transfer occurs through a stainless steel double-encased line to the PEW waste evaporator feed hold tank. Waste returned to the Tank Farm is transferred through a stainless steel double-encased line.

2.5.7 Calcined Solids Storage Facilities

The INTEC CSSFs provide double containment of the calcined solids by storing the solids in stainless steel bins enclosed in reinforced concrete vaults. For a complete discussion of a particular CSSF, see the appropriate facility safety analysis.

2.5.8 High-Level Liquid Waste Evaporator System

The HLLWE is used to concentrate waste solutions prior to calcination, resulting in a more efficient and cost-effective use of Tank Farm capacity and the calciner. A schematic of the HLLWE is presented in Figure 2-12.

2.5.8.1 Feed System. The blend tank (VES-NCC-101) is used as a feed storage tank. Tank Farm solution is transferred into the blend and hold cell via the existing inlet header. The waste is then transferred into the constant head feed tank (VES-NCC-152) using the existing airlift. Overflow from the constant head feed tank is returned to the blend tank. The feed stream is gravity fed from the feed tank into the evaporator flash column.

The line from the blend tank to the feed tank and the overflow return line contains provisions to clear plugs or restrictions through the use of steam, water, and decontamination solutions, or pressurizing to 1000 psig.

The feed system is designed so that the new evaporator and the calcination process can operate concurrently.

2.5.8.2 Evaporator. The evaporator consists of a flash column (VES-NCC-150), a reboiler (HC-NCC-350) with a demister section, and a condenser (VES-NCC-151).

When the level in the flash column reaches its normal operating level, steam is introduced into the shell side of the evaporator reboiler (HE-NCC-350). As the evaporator solution temperature increases in the reboiler section, its density decreases and the solution starts to rise. The decreased density, combined with the rising vapor bubbles, creates the thermosiphon effect in the evaporator. This draws the liquid from the bottom of the flash column, up through the tube side of the reboiler, and discharges the vapor and liquid to the upper portion of the flash column.

The liquid and vapor flow through a mist eliminator mesh pad that de-entrains droplets of liquid contained in the evaporator overheads. The overhead vapors next flow into the tube side of the evaporator condenser (HE-NCC-351). These overhead vapors are condensed by the flow of cooler treated water through the shell side of the condenser. The condensate is drained to the nonfluoride hot sump tank (VES-NCC-122).

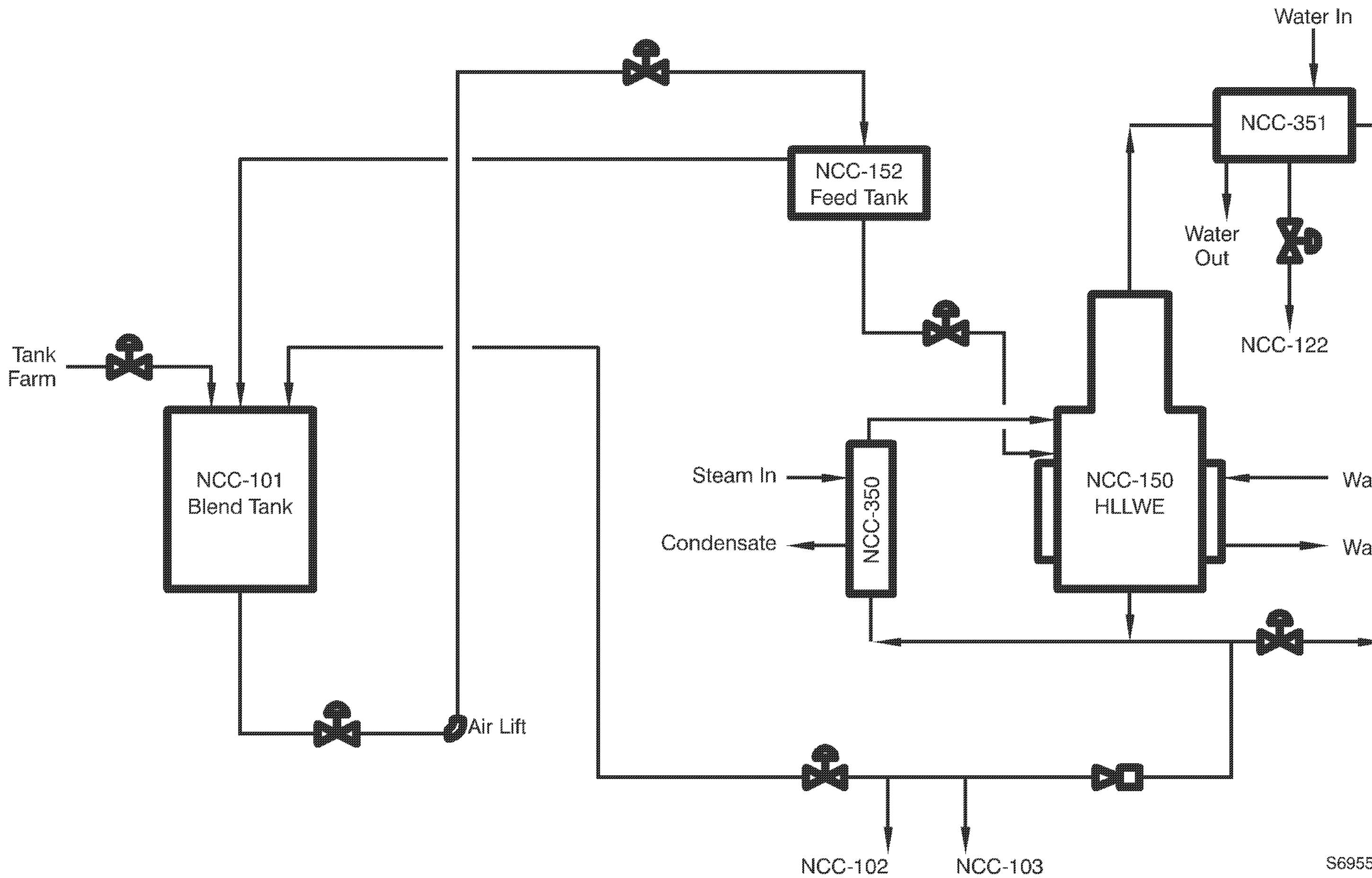

Figure 2-12. HLLWE schematic.

The de-entrained droplets from the separator fall towards the bottom of the flash column and combine with the liquid discharge from the reboiler. The evaporation process is continued until the specific gravity of the evaporator solution in the flash column reaches the desired setpoint. At this point, the steam to the evaporator is shut off. The evaporator bottoms are drained to the fluoride hot sump tank (VES-NCC-119) or transferred to the blend and hold tanks or the Tank Farm using an airlift or a steam jet. The evaporator bottoms may be cooled in the evaporator over time or by running the cooling coils and sparging.

2.6 Confinement Systems

The NWCF is designed to provide isolation and containment of radioactive material through multiple layers of confinement (primary, secondary, and tertiary confinement).

The primary confinement barrier is provided by the process vessels and the associated piping, and the POG system, which exhausts the process vessels. This primary confinement provides isolation of radioactive materials during normal operation.

The secondary confinement barrier is provided by the process cells and the associated H&V systems, which together enclose the primary system.

The tertiary confinement barrier is provided by the building and the facility ventilation and filter system.

These confinement capabilities, including confinement barriers and associated ventilation systems, are designed to maintain a controlled, continuous airflow pattern from the environment into the confinement building (tertiary barrier), and then from areas with lesser contamination potential to areas with greater contamination potential (secondary barrier).

The primary confinement is designed with a high degree of reliability to ensure that radioactive material will not leak into the secondary confinement system. If, however, this should occur, the secondary system will exhaust the potentially contaminated airflow through its filtration system to remove particulate activity prior to releasing the airflow to the environment.

The confinement system provides compliance with the following objectives in DOE Order 6430.1A:

1. To minimize the spread of radioactive and other hazardous materials within the unoccupied process areas

2. To prevent, if possible, or minimize the spread of radioactive and other hazardous materials to occupied areas

3. To minimize the release of radioactive and other hazardous materials in facility effluents during normal operation and anticipated operational occurrences

4. To limit the release of radioactive and other hazardous materials resulting from design basis accidents (DBAs) including severe natural phenomena and manmade events.

Table 2-36. Operating parameters for calciner area H&V system.

Pressure and Temperature Parameters				
Room Number	Room	Pressure Area[a]	Operating Temp. (°F)[b]	Maximum Temp. (°F)[c]
101	Valve access room	1	---	---
102	Hot sump tank cell	1	100	140
201	Corridor (south), third level	3	60 to 85	125
202	Lube oil console room	2	100	140
203	Decontamination collection tank and pump	1	100	140
204	Hot sump cell entry	2	65 to 85	125
205	Hot sump tank removal cell and valve operating area	2	---	---
206	Adsorber cell	1	150	150
207	Off-gas cell	1	120	160
208	Personnel decontamination room	4	65 to 85	125
209	Elevator entry	4	65 to 85	125
210	Elevator equipment room	4	95	135
211	Storage (same as corridor 212)	3	---	---
212	Corridor (north), third level	3	60 to 85	125
213	Cell entry	2	100	140
214	Calciner cell	1	100	140
215	Blend and hold cell	1	100	140
216	Filter cell and valve cubicle (transfer area 326)	1	100	140
217	Entry	3	65 to 85	125
218	Manipulator park and maintenance	2	85	125
219	Decontamination holdup tank cell	1	120	160
220	Storage (stair no. 3)	4	60 to 85	125
221	Return jet change room	2	85	125
222	Return jet cubicle	1	100	140
	stair no. 1	5	60 to 85	125
	stair no. 2	4	60 to 85	125
	stair no. 3	4	60 to 85	125
301	Entry	3	65 to 85	125
302	Storage	3	65 to 85	125

Table 2-36. (continued).

	Pressure and Temperature Parameters			
Room Number	Room	Pressure Area[a]	Operating Temp. (°F)[b]	Maximum Temp. (°F)[c]
303	Corridor	3	65 to 85	125
304	Auxiliary off-gas blower cell	2	85	125
305	Ventilation air cleanup	2	100	140
306	Equipment decontamination storage area	2	65 to 85	125
307	Decontamination cell entry	2	65 to 85	125
308	Decontamination cell	1	95	135
309	Filter handling cell	1	95	135
310	Entry	4	65 to 85	125
311	Operating corridor	3	65 to 85	125
312	Storage area (same as corridor 311)	3	65 to 85	125
313	Valve cubicle entry	2	95	135
314	Flowmeter cubicle	1	100	140
315	Fluidizing air blower room	4	95	135
316	Fluidizing air preheat room	4	100	140
317	Elevator entry	4	65 to 85	125
318	Corridor (south)	3	65 to 85	125
319	Personnel decontamination room	4	65 to 85	125
320	Gas and sampling cell	1	100	140
321	Blower cell entry	2	65 to 90	130
322	Off-gas blower cell	1	100	140
323	Crane maintenance area	1	95	135
324	Utility room	4	100	140
325	Utility corridor	4	100	140
327	CAM blower room	2	100	140
328	Sample cell entry	2	85	135
420	Decontamination cubicle entry	2	65 to 90	130
421	Decontamination cubicle no. 1	1	90	130
422	Decontamination cubicle no. 2	1	90	130
423	Calciner exhaust air plenum room	4	95	135

Table 2-36. (continued).

601	Calciner supply air plenum room	5	95	135

Natural Phenomena and UBC Specifications

	DBE[d]	OBE[d]	UBC[d]	DBT[d]	Standby Power
Supply air filter plenums		X		X	
Supply air blowers		X			X
Exhaust air blowers	X				X
Supply ductwork from branch HEPA filters to cells and cubicles	X				
Supply ductwork to other areas			X		
Duct supports in hardened areas	X				
Calciner area exhaust system from cell to the exhaust entrance to stack, including exhaust air filter plenums and exhaust ducts	X			X	
H&V controls for hardened areas	X				X
Chilled brine system			X		X
Scrubber system			X		X
Standby power supply	X				X

a. Legend:

Pressure Area	Differential Pressure (in. of W.C.)
1	(-) 1.0
2	(-) 0.5
3	(-) 0.3
4	(-) 0.1
5	Subatmospheric

(Differential pressure is area pressure relative to a stable atmospheric-pressure-sensing reference.)

b. Operating temperature is based on the calcination process being on-stream (operating) and the H&V supply air plenum operating with 100% chilled brine capacity available.

c. Maximum temperature is based on the calcination process operating and the H&V supply air plenum operating with total loss of cooling capability during summer design days.

d. Legend: DBE - design basis earthquake
OBE - operating basis earthquake
UBC - Uniform Building Code
DBT - design basis tornado

2.6.1 Ventilation Systems

Most NWCF H&V systems are once-through air supply and exhaust systems that include air filters, air washers, heating coils, fans, dampers, ducts, and control instrumentation.

The H&V systems maintain confinement of radioactive materials through a multiple-zone philosophy. Pressure differentials are maintained between the various building confinement zones and between the building and the outside atmosphere. These pressure differentials ensure that airflow is from zones with lesser contamination potential to zones with greater contamination potential, i.e., from occupied areas of the NWCF to the cell entryways, to the cell, and finally to the process vessels. Normal exit for most of the ventilation air is through a prefilter and two stages of HEPA filters and out the NWCF stack.

Seven different H&V systems serve the following locations in the NWCF:

1. Calciner area
2. Decontamination area
3. Control room
4. Office area
5. Standby generator room
6. Calcium nitrate addition room
7. Switchgear room.

The following subsections describe the systems, their functional objectives, and how they work.

2.6.1.1 Calciner Area H&V System. The system is designed to confine radioactive materials (1) under normal and abnormal operating conditions (tornado, earthquake, and fire) and (2) to the lowest practicable level for protection of the public and operating personnel. The HEPA filters in the exhaust plenums are expected to provide a decontamination factor (DF) of between 4×10^5 and 1×10^7 for particulate.

The calciner area H&V system primarily serves the second- and third-level corridors, process cells, and cubicles. The calciner area H&V system operating parameters are summarized in Table 2-36.

The main components of the calciner area H&V are two supply plenums (HV-NCM-785-1 and -2), three supply blowers (BLO-NCM-271-1, -2, and -3), two exhaust plenums (HV-NCM-771-1 and -2), three exhaust blowers (BLO-NCM-285-1, -2, and -3), and the associated ductwork and instrumentation.

This system is a once-through type. Before entering the supply plenum, air passes through a tornado-missile-protected intake and a tornado-restriction damper. The intake is provided with a heat pipe that receives heat from the combined exhaust flow of the calciner area and decontamination area H&V systems and preheats the calciner area H&V supply air. The supply air then enters the supply plenums.

Each supply plenum is equipped with a heating coil, prefilter, HEPA-grade filter, and cooling coils. During normal operation both plenums are operated at the same time. During the changeout of a filter in one plenum, the plenum undergoing changeout is shut down, and the other plenum carries the system load. With only one plenum operating, the airflow to certain areas is reduced, however, because each plenum can only handle 70% of the normal system flow. While the airflow is reduced, the pressure differentials throughout the system remain the same.

Heat supply to the preheat coils is from a 35 lb steam supply. A throttle valve controlled by a low-temperature-indicator switch determines when and how much steam flows through the coils. The cooling coils use a glycol solution to cool the supply air when necessary. The cooling coils are controlled on the basis of the outlet temperature of the supply air blowers.

The primary function of the HEPA-grade filters in the inlet plenums is to prevent the release of activity caused by pressurization of the system in some manner. The filters in the plenum also serve to clean the air before it enters the system and to thereby prolong the time between changeouts of the exhaust HEPA filters.

Motive force for the supply air is provided by the three supply blowers. Each blower is rated at 50% of the system capacity; therefore, two blowers are operated while one is kept on standby. The normal flow provided by two blowers is about 30,000 cfm.

The blowers are normally controlled from the control room, but they also may be controlled from the local H&V control panel. When the local hand switch for a given blower is placed in the OFF position, the blower cannot be started from the control room. This protects maintenance personnel who might be working on the blower. In addition, the blowers cannot be started until the exhaust blowers are in operation (which prevents system pressurization).

After the supply air leaves the blowers, it is distributed to the various areas through the ductwork.

On most of the major cells, the inlet is provided with a manual damper, a HEPA filter, and an automatically controlled damper. The outlet is provided with a manually controlled damper and a metal mesh mist eliminator that is open at all times. The manual outlet damper is used in coarse-balancing the flow through the cell and, in turn, the pressure drop between the cell and other areas. The automatic damper on the inlet maintains the fine adjustment of flow and differential pressure. The small outlet in the cell is provided for when the cell is being decontaminated. During decontamination, the inlet and outlet dampers are closed with the small outlet providing airflow out of the cell. Not all cells are provided with HEPA filters on the inlets.

The exhaust ductwork for the decontamination cell entry (307), the decontamination cell (308), the filter handling cell (309), the decontamination cubicle entry (420), and the decontamination cubicles (421 and 422), along with some decontamination equipment, is eventually ducted together, and the H&V air stream is cleaned by a scrubber system. The purpose of the scrubber system is to remove corrosive vapors from the H&V stream. The scrubber assembly is equipped with plastic packing, a scrub solution spray head, a mist eliminator, and a decontamination spray head. Motive force to move air through the system and back into the calciner area H&V system is provided by a blower (BLO-NCD-289).

After leaving the various cells and cubicles, the air goes to the calciner area H&V system exhaust tunnels. The tunnels dump the air to the exhaust air plenums.

Each of the two exhaust air plenums is rated at 100% of the system capacity. Each plenum consists of a prefilter and two HEPA filters, all in series. Instruments have been provided to monitor the differential pressure across each filter bank and alarm when the pressure becomes too high. A radiation monitor is provided in front of the first stage of HEPA filters to monitor the buildup of radioactivity. During normal operation, one plenum is operated while the other is on standby or being maintained. The filters are changed manually via a bagout system. To minimize exposure, the filters, during normal operation, are not permitted to go beyond a certain level of radioactivity buildup.

The exhaust air ducts are stainless steel. The exhaust system contains differential-pressure-controlled throttling dampers in the exhaust duct from each cell and from the corridors to maintain the desired pressure differentials. All process-cell exhaust ducts discharge into a common underground concrete duct (with a stainless steel floor liner) that connects to the exhaust system plenums. One-way dampers in each cell-exhaust duct provide protection against pressurization of the calciner cell or the common exhaust duct. Two identical calciner exhaust area plenums are provided; one is in service and the other is on standby. At the entrance to the exhaust plenums, impingement plates and automatic water spray nozzles (with a manual override) provide emergency cooling and fire protection.

A stainless steel mesh moisture-separator prefilter prevents moisture or corrosive liquid carryover. Each exhaust plenum contains two banks of testable HEPA filters to protect against the release of radioactive contaminants. Three exhaust blowers, each rated at 50% of the system capacity, are provided; two blowers operate and one is on standby. The exhaust air discharges through the NWCF H&V stack. Each exhaust plenum (HV-NCO-785-1 and -2) is provided with a RAM and differential pressure indicators. If either of these monitored limits exceeds pre-established setpoints, the plenum is isolated and the filters are replaced as necessary.

The ventilation system for the adsorber cell requires special equipment to prevent the cell temperatures from falling below the dewpoint of the POG passing through the cell equipment. Therefore, the adsorber cell supply air duct is provided with a steam reheat coil to maintain the correct cell air temperature and prevent moisture condensation in the POG.

The ventilation airflow rate to the process cells generally maintains six to eight changes per hour. However, in the case of the off-gas blower cell, 12 changes per hour are maintained to help remove heat from the operating blower.

Manually operated isolation dampers are provided on all supply and exhaust plenums and blowers to permit isolation for servicing.

Inlet vanes on the exhaust blowers automatically control the negative pressure in the exhaust header. Instruments are provided to control and indicate pressure differentials between confinement zones. Alarms are provided in the control room to indicate pressure differentials that are not within the prescribed range. Should one supply or exhaust blower fail, the third standby blower automatically starts. When cell hatches are opened, the supply air via the inlet ventilation ducts are cut in half to maintain an adequate inlet velocity across the hatch opening. With refrigerant cooling in the inlet plenums, occupied areas are maintained at a maximum of 85°F dry bulb and 40% relative humidity (RH) when the outside temperature is 90°F dry bulb and 60°F wet bulb.

The three exhaust blowers provide the motive force for the exhaust air. Normally, two of the blowers are operated while the third is on standby. If one of the operating blowers fails for some reason, the switch to the standby blower is made automatically. The system has been designed so that the blowers can be started from the control room or locally. If the local switch is in the OFF position, the control room switch cannot start a given blower. In this manner, maintenance personnel working on a blower are protected from the startup of the blower by someone in the control room who is unaware of the ongoing work. In addition, the supply blowers cannot be started before the exhaust blowers are operational. This prevents pressurization of cells and cubicles.

After leaving the blowers, the exhaust air is vented out the NWCF H&V stack. An isokinetic sampler diverts a small amount of flow through a filter situated in front of the radiation detector for the system. The radiation detector serves to monitor the releases from the system and warn when release limits are approached or exceeded. Before exiting via the stack, the exhaust flows over a heat pipe (HP-2601-1) to aid the preheating of the supply air.

2.6.1.2 Decontamination Area H&V System. With the exception of those cells, cubicles, and equipment served by the calciner area H&V system, the decontamination area is served by the decontamination area H&V system. In addition, the maintenance area (428) is served by this system.

The main components of the system are a supply plenum (HV-NCD-786), two exhaust plenums (HV-NCD-787-1 and -2), two exhaust blowers (BLO-NCD-287-1 and -2), and the associated ductwork and instruments.

Supply air is pulled into the supply plenum by way of a louvered inlet. The plenum contains preheat coils, roughing filters, an evaporative cooler, heating coils, and a blower. Both the preheat and heating coils are steam heated. The function of the roughing filters is to clean the air before it enters the system. Instruments are provided to monitor the ΔP across the filters. Changeout of the filters requires the shutdown of the decontamination area H&V system. The evaporative cooler and the preheat and heating coils are controlled on the basis of the incoming supply air temperature.

Motive force to move the supply air is supplied by a blower (BLO-NCD-286), which is located inside the plenum. Switches for controlling the blower are located both on a local control panel and on the control room panel. Starting and stopping of the blower can be accomplished from either location. If the local switch is in the OFF position, the blower cannot be started from the control room. This design was incorporated as a protection for maintenance personnel working on the blower.

After leaving the supply plenum, the air is distributed to the various areas served by the system. Airflow and pressure differentials in the areas and equipment are controlled and maintained by dampers, both manual and automatic. Coarse control is established with the manual dampers, and fine control is achieved with the automatic dampers. The automatic dampers are in most cases controlled by pressure-sensing elements in the various areas served.

After the ventilation air leaves the areas served by the system, the air eventually enters the main decontamination area exhaust duct. This duct then feeds the air to the exhaust air plenums. Each plenum is rated at 50% of the system capacity, and both plenums are normally operated. Each plenum is equipped with a roughing filter and two HEPA filters in series. Instruments are provided across each stage of filtration to monitor pressure drop. Alarms are provided in the control room that activate when the pressure drop across a filter reaches the alarm setpoint. In addition, the first stage of HEPA filters in each plenum is equipped with a RAM. Each RAM is provided with an alarm in the control room that activates when a particular level of radioactivity is reached.

Exhaust motive force for the system is provided by the two exhaust blowers, each of which is rated at 50% of the system capacity. The blowers can be controlled either from the local control panel or from the control room. If, however, the local hand switch is in the OFF position, the blowers cannot be started from the control room. This provides protection to personnel working on a blower. The personnel could be injured if the blowers were started by someone in the control room who is unaware of the work going on. The blowers are also equipped with instruments to shut down the blowers in the event of excess vibration. Instruments have also been provided that prevent the startup of the supply blowers until the exhaust blowers are started and a certain ΔP is established.

Normally, both plenums and blowers are operated together. If a shutdown of a plenum or a blower is needed, operations within the areas served continue but at a reduced capacity (50% or less).

The same airflow philosophy is maintained in the decontamination area H&V system as in the calciner area H&V system. However, neither the supply plenum room nor the exhaust plenum room for the decontamination area H&V system are protected against the DBE or DBT, see Table 2-37.

2.6.1.3 Control Room H&V System. A separate H&V system is provided for the control room to (1) protect it from contamination and (2) maintain the proper temperature and humidity needed for the NWCF computer and the control room electronics. The mechanical equipment associated with the system is located in room 434 adjacent to the control room.

Because of the very low probability of contamination in the control room, the HVAC system is normally run in a recirculation mode. This minimizes the amount of heating and cooling needed.

Inlet air to the system enters through an intake, located on the south side of the building, that is protected to withstand a DBT missile. The amount of intake air is regulated by a damper controlled on the basis of the control room subfloor temperature indicator (T-1782-1C). Before entering any of the mechanical equipment, the air is filtered by a pleated filter (AF-782-1) and a prefilter (AF-782-2).

During normal operation of the system, the air moves through an air conditioning unit (AC-NCM-782) that cools the air as necessary. The air then moves through one of two heating coils (HU-2438-1 or HU-2439-1), which heats the air as necessary. Motive force to move the air through the system is provided by a blower that is an integral part of the air conditioning unit. After leaving these components, the air dumps into the control room and the computer equipment room (439). When the air leaves these rooms, it either is dumped to the outside through an outlet that is protected to withstand the DBT or is recirculated.

If either the blower or the air conditioning unit fails, a standby blower (BLO-NCM-282) and an air conditioning unit have been provided. The standby blower is activated on the basis of low pressure (PSL-1782-1) at the outlet of the air conditioning unit. The blower can also be activated by hand.

The correct pressure and flow through the control room are controlled by the exhaust damper. The heating coils and air conditioning units are controlled on the basis of the temperature in the control room.

The control room H&V system contains a single-package air conditioning unit, which has a hot water heating coil to maintain the necessary computer conditions. An economizer cycle is provided to take advantage of cooling with outside air during the intermediate seasons. If the air conditioning unit is being serviced, a standby air conditioning unit is provided.

Steam-hot water converters furnish hot water for heating the control room and office systems. Electronic instrument specifications dictate the temperature and humidity in the control room (70°F dry bulb and 45% RH). The control room design pressure is positive pressure.

Table 2-37. Operating parameters for decontamination area H&V system.

Pressure and Temperature Parameters

Room Number	Room	Pressure Area	Normal Winter Temp. (°F)	Normal Summer Temp. (°F)
415	Low-level decontamination room and mezzanine floor plan	4	70	85
416	Storage	3	70	85
417	Vehicle entry	5	60	85
418	Equipment decontamination room	3	70	85
419	Transfer	4	70	85
426	Decontamination exhaust air plenum room	4	60	95
428	Maintenance area	5	60	85
429	Decontamination solution makeup room	5	60	95
430	Elevator entry	5	70	85
431	Vestibule	5	50	85
443	Nitric acid recycle tank vault	4	68	85
503	Decontamination supply air plenum room	5	60	95

NOTE: A minimum of two air changes occurs per hour.

Natural Phenomena and UBC Specifications

	DBE[b]	BE[b]	UBC[b]	DBT[b]	Standby Power
Supply air filter plenum			X		
Supply air blowers			X		
Exhaust air filter plenums			X		
Exhaust air blowers			X		X[c]
Supply and exhaust duct			X		
Work and supports					
HVAC controls			X		
Standby power supply	X				

a. Legend:

Pressure Area	Differential Pressure (in. of W.C.)
1	(-) 1.0
2	(-) 0.5
3	(-) 0.3
4	(-) 0.1
5	Subatmospheric

(Differential pressure is area pressure relative to a stable atmospheric-pressure-sensing reference.)

b. Legend:
DBE - design basis earthquake
OBE - operating basis earthquake
UBC - Uniform Building Code
DBT - design basis tornado

c. Only one exhaust air blower is supplied with standby power.

2.6.1.4 Office Area H&V System. The offices and the adjacent corridor in this location are ventilated and cooled by a once-through evaporative cooling system. The supply air for this system comes from the decontamination area supply plenum. Three reheat zones provided with hot water coils maintain temperature control. The temperature and humidity in the offices are 80°F dry bulb and 46% RH. Areas served by the office system are detailed in Table 2-38. This system serves the office areas in the southwest part of the ground floor of the NWCF. Depending upon the time of year, this system may operate in a once-through manner, a recirculation manner, or a combination of the two.

Supply air to the office area H&V system is provided by the decontamination area H&V system supply plenum. The supply air moves through a small plenum (HV-NCM-784) located in the decontamination supply air plenum room (503). The plenum is equipped with a prefilter (AF-284-1), an evaporative cooler (EC-784-1), and a blower (BLO-NCM-284) to provide motive force to the supply air. The evaporative cooler is controlled on the basis of the supply air temperature. In addition, the amount of air supplied and the amount of recirculation are determined by the supply air temperature.

After leaving the plenum, the ventilation air is distributed to the various areas through the ductwork. The areas served have been divided into five zones. Installed in the ductwork leading to each zone is a water heating and cooling coil. A temperature indicator-controller installed in each zone controls the heating coils.

After leaving the various office areas, the air is either recirculated or exhausted to the outside. A constant 3030 cfm stream from the change and toilet areas is exhausted to the atmosphere by a blower (BLO-NCM-283). Motive force to recirculate or exhaust the air from the rest of the system also is provided by another blower (BLO-NCM-290). All of the blowers are controlled by hand switches located in the immediate area of the blowers. In addition, the blowers are provided with interlocks that prevent their startup unless certain conditions are complied with. Airflow to the various areas is controlled by manual dampers.

2.6.1.5 Standby Generator Room H&V System. A unique H&V system is provided for the standby generator room to maintain the room in a contamination-free state to and provide the proper environment for the operation of the standby generators (GEN-NCM-440-1 and -2). The standby power system is discussed in subsection 2.8.2.

Inlet air to the room enters by way of an opening on the roof of the NWCF that is protected to withstand the DBT. The opening is provided with filters to keep dust and foreign matter out and provide protection in the event of some pressurization of the room associated with a radiological release. The amount of air entering the opening is controlled by a temperature indicator-controller (TIC-2432-1). The temperature indicator-controller causes the damper to throttle to maintain a room temperature of between 60 and 80°F. The damper fails closed.

Movement of air from the room is achieved by a blower (BLO-NCM-280) that is housed in a plenum with a filter on the intake. A portion of the air is exhausted to the outside, and a portion is recirculated. Incorporated in the recirculation line is a heater (UH-NCM-774) that is activated by TSL-2280-1 and TISH-2432-1.

Activation of TISH-2432-1 will shut off the heater and activate the dampers on the outlet and recirculation lines. Too low of a temperature could cause the fire sprinkler system to freeze while too high of a temperature could cause the system to activate. Water spraying in the room could damage the generators.

Table 2-38. Operating parameters for office area H&V system.

Room Number	Room	Pressure Area	Normal Winter Temp. (°F)	Normal Summer Temp. (°F)
401	Corridor (entry)	5	72	78
402	Decontamination office	5	72	78
404	Women's change and toilet room	5	72	78
406	Men's change and toilet room	5	72	78
407	Health physics office	5	72	78
408	Storage room	5	72	78
409	Corridor (central)	5	72	78
410	Janitor room	5	65	85
411	Corridor (to toilets)	5	72	78
435	Corridor (to control room)	5	72	78
436	Office	5	72	78
437	Office	5	72	78
433	Telephone equipment room	5	80	85

NOTE: A minimum of two air changes occurs per hour.

a. Legend:

Pressure Area	Differential Pressure (in. of W.C.)
1	(-) 1.0
2	(-) 0.5
3	(-) 0.3
4	(-) 0.1
5	Subatmospheric

(Differential pressure is area pressure relative to a stable atmospheric-pressure-sensing reference.)

Cooling and combustion air for the diesel is taken from the room. The cooling air is drawn across the diesel's radiator and then is exhausted to the outside or is recirculated to the room. The room temperature determines what happens with the dampers (TCV-2432-1B, -1C, and -1D) controlled by the temperature indicator-controller (TIC-2432-1).

Ventilating and heating of the standby generator room (432) are necessary to maintain the room temperature at 95°F dry bulb [maximum, without a standby generator (GEN-NCM-440-1) operating] in summer and 60°F dry bulb (minimum) in winter. Makeup air is drawn through a filtered outside air intake and is discharged to the outdoors by the generator fan.

When the standby generator is operating, the room temperature is controlled by intake, discharge, and recirculation air dampers. The dampers are modulated by a room thermostat that uses radiator heat to maintain the design room temperature during winter and provide 100% exhaust during summer to maintain a maximum room temperature of 95°F when the outside air temperature is 90°F.

When the generator is not operating, ventilation is provided by a blower controlled by a room thermostat. The blower is provided with both normal and standby power. Heating is provided by a unit controlled by a room thermostat.

The H&V equipment for the standby generator room was designed and constructed in accordance with the UBC. However, the standby generator intake, discharge, and recirculation dampers and room thermostat are designed to withstand the DBE. Ventilation air intake and exhaust outlets are protected from tornado-generated missiles.

2.6.1.6 Calcium Nitrate Addition Room H&V System. Ventilation is provided by an electric-motor-driven exhaust blower mounted on the roof. The blower is controlled by a room-mounted thermostat. Makeup air is drawn into the area through wall louvers. Heating is provided by two two-stage electric unit heaters controlled by a room thermostat. The H&V equipment for this area was constructed in accordance with the UBC.

Temperature control is maintained by heating the room air when the room temperature drops below 60°F and exhausting the room air when the room temperature goes above 95°F. Two heater units (UH-NCM777-1 and -2), which are identical in components and operation, provide heating. An integral recirculation fan is provided in each heater. The fans are activated by a hand switch for each unit. The heaters are activated by two temperature switches (TSL-277-1 and -2), but the heaters will not run unless the hand switches are in the ON position.

Air is exhausted by means of a blower (BLO-NCM-291) mounted on the roof of the room. The blower can be activated by placing the associated hand switch in the HAND position. However, the normal mode of operation is to place the hand switch in the AUTO position. The blower is then activated by a temperature switch (TSH-2291-2) when 95°F is reached in the room. Inlet air is supplied from outside by opening the rollup door to the room.

The H&V components for this system were constructed to withstand seismic activity in accordance with the UBC.

2.6.1.7 Switchgear Room H&V System. Because the switchgear room (433) provides power to many critical components and systems, the H&V system is designed to withstand the DBE. The proper temperature for functioning of the room components can be maintained. In addition, the room's H&V system provides protection against contamination from other areas. Temperatures of a maximum of 104°F in summer and a minimum of 60°F in winter are maintained by the system. To prevent the buildup of battery off-gas in the room, the system provides a constant change of air. The ventilation air intake and exhaust outlet are protected from tornado-generated missiles.

Pulling in outside air or heating is used to maintain the design temperature in the room. When the room temperature drops below 60°F, a heater (UH-NCM-775) is activated by a temperature switch (TSL-2775-1). The heater is provided with a blower that is controlled by a hand switch. The hand switch must be in the ON position for the heater and blower to work. Provided the hand switch is in the ON position, the blower constantly recirculates air through the heater unit and the heater cycles according to the temperature.

Normal air changes within the room are effected by means of a blower (BLO-NCM-288) exhausting a 200 cfm airstream to the outside. Makeup air is received via an inlet on the roof of the building. The inlet is protected to withstand the DBT and is provided with a filter (AF-432-1) and a damper. The damper is normally closed but has sufficient infiltration to replace the 200 cfm exhausted.

When the room temperature reaches 80°F, a blower (BLO-NCM-281-1) activates and the damper (TCV-2281-1) on the inlet opens. The blower and the damper are controlled by a temperature switch (TSH-2281-1) and a hand switch. The hand switch must be in the AUTO position and the temperature switch must be at the setpoint for the activation to take place. The damper may be opened and the blower may be started by placing the hand switch in the HAND position. In both cases, the air is exhausted to the outside by way of an outlet that is protected to withstand the DBT.

A standby blower (BLO-NCM-281-2) is provided to take over if the main blower fails. The standby blower is a activated by a pressure switch (PSL-2281-1) on the outlet of the main blower. A 10 second delay is provided before startup of the standby blower. This prevents startup of the standby blower during momentary power dips caused by transient disturbances or system transfers.

The electric heater unit and both of the exhaust blowers are connected to standby power. The small exhaust blower is not.

Ventilation air is drawn into the switchgear room through a filtered outside air intake on the roof. Redundant blowers connected to normal and standby power are provided to maintain a subatmospheric pressure within the room. Only one of the blowers is operated at a time. A 10 kW heater provides the necessary heat input. The system exhaust air is exhausted to the outside. The initial operation of a blower is achieved by manual start with automatic switchover to the standby blower upon loss of airflow. Heating is controlled by a room thermostat.

2.6.2 Process Off-Gas

Cleanup and confinement of the POG are maintained by an extensive off-gas cleanup train that is backed by the APS. The dry and wet NWCF off-gas cleanup system is designed to collect entrained particulate and volatile ruthenium compounds from a gas stream flowing from the calciner vessel at 1500 scfm and maintained at temperatures below 650°C (1202°F). The off-gas cleanup system provides DFs of 3×10^9 for particulate removal and 1×10^3 for volatile ruthenium removal, which complies with DOE guidelines specified in DOE Order 5400.5 in maintaining ALARA releases to the environment. Any particulate activity that is not removed by the NWCF off-gas cleanup system is reduced by a factor of about 6×10^3 by the APS before exiting via the INTEC Main Stack.

Two streams leave the calciner vessel: a contaminated off-gas stream and the solid calcine product. The contaminated off-gas stream contains a certain amount of calcine fines that are carried out of the vessel. The main purpose of off-gas cleanup is to remove the particulate and some volatile material before release to the environment. Cleanup is achieved using scrubbers, condensers, filters, and similar equipment. In addition, the vent streams from tanks and vessels are fed into the end portion of the off-gas cleanup system.

2.6.2.1 NWCF POG System. The NWCF POG system collects particulate and volatile ruthenium compounds carried out of the calciner in the off-gas. The POG system employs a series of components to collect progressively smaller particles.

Even before the POG leaves the calciner, some off-gas cleanup is achieved. The NWCF calciner has an expanded upper section and a baffle assembly in the upper portion of the vessel. The expanded section decreases the velocity of the gas leaving the calciner, which lowers the amount of particulate carried along with the off-gas. The baffle assembly further reduces the particulate carryover by knocking larger particles out of the off-gas stream.

After leaving the calciner, the cyclone (VES-NCC-107) removes the remaining larger particles and adds them to the product stream being transported to solids storage. A wet scrubbing portion of the system, including mist eliminating equipment and de-entrainment separators, then removes the particles that penetrate the cyclone. Particulate matter collected in the wet scrubbing portion of the system is dissolved and recycled back to the feed system for recalcination. The recycle of scrubbing solution reduces the net processing rate of the calciner by about 15%.

After passing through the wet scrubbing portion of the system, the off-gas can be reheated for the adsorber beds, which collect unburned hydrocarbons and volatile ruthenium compounds. An additional mist eliminator is included in the off-gas cleanup train, downstream of the ruthenium adsorbers, for moisture and particulate removal. The off-gas then passes through another heater and four parallel filter plenums, each containing one HEPA-grade prefilter and two HEPA filters in series. When loaded with solids, filters are replaced remotely and transferred to the filter handling cell. The old filters are acid-leached, rinsed, and dried. The old filters, reduced to LLW, are then packaged in LLW boxes for disposal at the RWMC.

After passing through the final HEPA filters, the off-gas enters the off-gas blowers, which maintain the necessary vacuum in the calciner system. The off-gas then travels underground to the APS and out the INTEC Main Stack. An overall DF of between 1.8×10^{13} and 1.9×10^{18} for particulate and 1×10^{3} and 4×10^{4} for volatiles is expected from the system.

The adsorber cell, POG filter housings, pipe tunnels, and any system associated with the hot condensable off-gas are heated and insulated to preclude condensation in vessels and piping.

2.6.2.2 Equipment and System Description. The following subsections describe in detail the various parts of the off-gas cleanup system.

2.6.2.2.1 Cyclone (VES-NCC-107)—The cyclone is constructed of Type 347 stainless steel for resistance to hot (approximately 500° to 600°C [932° to 1112°F]) off-gas containing NO_x and possibly small concentrations of hydrocarbons, carbon, fluorine, and chlorine. The solids are discharged from the bottom into a 6 in. diameter drop leg. The cyclone collects at least 50% of all particles larger than 2μm in diameter (maximum density is 2.0 g/cm^3) and at least 99% of all particles larger than 10μm in diameter. A decontamination system (spray head) capable of spraying all internal surfaces is provided. Other nominal operating parameters follow:

Off-gas flow	2650 cfm gas
Off-gas pressure	10.75 psia (42 in. of W.C. vacuum)
Off-gas temperature	500° to 600°C (932° to 1112°F)
Moisture	40 vol%

The following design parameters also apply:

Maximum pressure drop	12 in. of W.C.
Evaluated maximum pressure	13.8 psig
Evaluated maximum vacuum	12.3 psig
Corrosion and erosion allowance	1/8 in. (minimum).

The cyclone is a static device; therefore, operational control consists mainly of monitoring the ΔP (PDT-107-1) in the cyclone and the temperature (TE-107-1, -3, -4, and -5) of the calcine leaving it. DCS alarms on three pressure instruments (PD107-1C, PD107-2C, and PD107-4C) indicate departures from the operating envelope and the need for operator action.

2.6.2.2.2 Quench Tower (VES-NCC-109)—The function of the quench tower is to cool the off-gas to its dewpoint. The tower also collects some solids from the off-gas stream. The quench tower accommodates a relatively high gas velocity because the swirling flow through the calciner vessel reduces carryover by throwing the spray against the wall. A DF of between 1.5 and 2.5 for particulate and 1 and 2 for volatile components is expected from the tower.

The tower is constructed of Nitronic 50 stainless steel for resistance to a scrubbing solution containing 1.5 M acid; 4 M nitrate and up to 10,000 ppm chloride; and fluoride complexed by aluminum, zirconium, and boron. The tower is provided with an access hatch for inspection and maintenance and a decontamination system (spray head) capable of spraying all internal surfaces and flooding the vessel. The decontamination system is independent of the quench spray system. Other operating parameters follow:

Gas flow	2650 cfm
Gas pressure	10.3 psia (54 in. of W.C. vacuum)
Water vapor	40 vol%
Inlet gas temperature	842°F (450°C)
Outlet gas temperature	167°F (75°C)
Incoming liquid temperature	104°F (40°C)
Liquid discharge temperature	~149°F (~ 65°C)
Allowable spray carryover	2 gpm

Maximum gas pressure drop	3 in. of W.C.
Vessel design temperature	842°F (450°C)
Design pressure	30 psig to 7.5 psig vacuum
Corrosion allowance	1/8 in. (minimum)
Available liquid pressure	50 psig.

The primary item to be controlled in operating the quench tower is the amount of scrub solution entering the vessel. This is indicated by a venturi meter (FE-332-1). If the solution reaches a depth of 40 in. above the bottom of the conical end of the vessel, a HI alarm sounds in the control room. Manual action on the part of an operator is necessary to adjust the flow by way of a valve (HV-332-1) in the scrub solution line.

The other item that is monitored in the quench tower is the temperature (TE-109-1) of the off-gas leaving it. The off-gas line can withstand a temperature of 400°F (204°C). Thus, damage could occur if the off-gas temperature were to become too high. Normally, the operators will periodically check the off-gas temperature and make adjustments in the scrub solution to maintain the desired operating temperature. If the temperature rises to 200°F (93°C), a HI alarm (T109-1C) is activated. At 300°F (149°C), a HIHI alarm (T109-1C) is activated and an automatic shutdown of the process system is initiated by the RSS. When the temperature drops back below the setpoint, water injection is terminated.

2.6.2.2.3 Venturi Scrubber (VES-NCC-511)—The function of the venturi scrubber is to collect as many of the airborne solids as feasible in the atomized scrubbing solution. The scrubber also condenses some of the water vapor from the off-gas. The scrubber is designed for a pressure drop of 60 in. of W.C. and is fabricated of Nitronic 50 stainless steel for corrosion resistance. A control valve (FV-332-2) is located on the scrub flow to the venturi to vary the pressure drop across the venturi. Nitric acid is added to the scrubbing solution to maintain approximately a 1.5 M HNO_3 solution. The scrubbing solution contains approximately 1.3 M fluoride and could contain up to 10,000 ppm chloride if high-level waste is being blended with the zirconium waste. A DF of between 100 and 400 for particulate and 1 and 2 for volatiles is expected from the scrubber. Additional operating parameters follow:

Inlet gas flow	2650 cfm gas
Inlet gas pressure	10.2 psia (57 in. of W.C.)
Inlet gas temperature	167°F (75°C)
Scrubbing solution flow	35 gpm
Scrubbing solution temperature	104°F (40°C)
Corrosion allowance	1/8 in. (minimum).

Control of the venturi scrubber is achieved by controlling the amount of scrub solution to the scrubber and the ΔP across it. Scrub solution is supplied to the scrubber by line 2”-PSAB-1914, which is fitted with a flow monitoring device (FE-332-2) that controls a flow valve (FV-332-2). Throttling of the valve maintains a 35 gpm flow of scrub solution to the venturi. A low-flow alarm (F332-2C LO) is activated when the flow drops to below 20 gpm. The ΔP is controlled by a damper device in the throat of the venturi. The damper is controlled by HIC-511-1 based on the ΔP sensed across the venturi by a HI alarm (PD511-1C), which is activated at 70 in. of W.C.

2.6.2.2.4 Venturi Scrubber Knockout Drum (VES-NCC-111)—The function of the KO drum is to collect and remove at least 95% of the scrubbing solution (approximately 8 to 9 gpm) atomized in the venturi scrubber. The remaining solution is collected in the mist eliminator. The separator is fabricated of Nitronic 50 for resistance to the chloride-containing scrubbing solution. Alarms are provided for high off-gas temperature, high pressure drop, and high liquid level. The vessel has an access hatch for inspection and maintenance purposes and a decontamination system (spray head) capable of spraying all internal surfaces. The operating parameters follow:

Inlet gas flow	2650 cfm gas
Inlet gas pressure	8.0 psia (118 in. of W.C.)
Inlet gas temperature	149°F (65°C)
Outlet gas temperature	149°F (65°C)
Water vapor	36 vol%
Maximum pressure drop	3 in. of W.C.
Design pressure	30 psig to 7.5 psig vacuum
Corrosion allowance	1/8 in. (minimum).

2.6.2.2.5 Off-Gas Condenser (HE-NCC-333)—The condenser is installed downstream from the venturi scrubber KO drum and upstream from the mist eliminator. Use of the condenser is optional. A DF of between 1 and 2 for volatiles is expected from the condenser. Use of the condenser changes the operating parameters for the downstream components (lower gas flow). However, the design basis off-gas flow is with the condenser not operating. A temperature controller (T333-1C) (DCS loop) is provided to adjust the off-gas temperature as the off-gas exits from the condenser.

The condenser is a shell-and-tube heat exchanger constructed of Nitronic 50, designed for a pressure range of about 150 psig to 7.5 psig vacuum. The gas is on the tube side to facilitate decontamination. Additional operational parameters follow:

Inlet gas flow temperature	140°F (60°C)
Inlet gas temperature	86°F (30°C)
Noncondensable gas flow	975 scfm
Inlet water vapor	540 scfm
Cooling water temperature	77°F (25°C)
Operating gas pressure	7.9 psia (121 in. of W.C.)
Maximum gas pressure drop	10 in. of W.C.

2.6.2.2.6 Mist Eliminator (VES-NCC-110)—The mist eliminator consists of two stages in a common vessel. The first stage is a Halar mesh spray collector, e.g., a mist eliminator. The second stage is a deep-bed filter designed to collect both fine mist carryover from the scrubber and fine particles that penetrate through the scrubber. Thus, the mist eliminator serves both as a mist collector and as a washable prefilter to reduce the solids load going to the adsorbers and filters. Both elements have irrigating nozzles spraying on the upstream face and a flush system. The vessel is fabricated of Nitronic 50 stainless steel. The vessel has pressure taps to measure pressure drops across each of the elements, an access and inspection hatch, and a decontamination system (spray nozzle). A DF of between 1.5 and 4 for particulate is expected from the mist eliminator. Performance is dependent upon velocity, which is controlled by the upstream components. Alarms are provided for high pressure differential (PD110-1C and PD110-2C) and high liquid level (L110-1C). Additional operating parameters follow:

Off-gas flow	2650 cfm gas
Off-gas inlet pressure	7.6 psia (130 in. of W.C.)
Off-gas inlet temperature	140°F (60°C)
Moisture	36 vol%
Maximum pressure drop (clean)	4 in. of W.C.
Vessel design pressure	30 psig pressure to 7.5 psig vacuum
Corrosion allowance	1/8 in. (minimum).

2.6.2.2.7 Scrub Hold Tank (VES-NCC-108)—The scrub hold tank has a capacity of approximately 1200 gal (a design capacity of approximately 2000 gal) and is a horizontal cylindrical tank. Functionally, the scrub hold tank accumulates scrubbing solution and the solids collected in the solution. Nitric acid is added to the tank to dissolve the collected solids. The scrubbing solution and dissolved solids are discharged to the blend and hold tanks approximately once a batch. The scrub hold tank was designed for a pressure range of approximately 30 psig to 7.5 psig vacuum and is fabricated of Nitronic 50 with a 1/8 in. (minimum) corrosion allowance. The vessel has a heating system capable of heating 500 gal of liquid to 158°F (70°C) in 12 hours. The heating system also is capable of being used as a cooling system. The scrub hold tank also has a sparge system to keep the solution stirred and a decontamination system (spray heads) capable of spraying all internal surfaces. In addition to the penetrations necessary for the above systems, the tank has an access manhole, pump flanges, and several nozzles of various sizes. DCS alarms are provided for temperatures (T108-1C) that are higher than 160°F (71°C), high and low liquid levels (L108-1C), and high specific gravity (D108-1C).

2.6.2.2.8 Recycle Pumps (P-NCC-208-1 and -2)—The scrubbing solution recycle system includes two pumps connected in parallel, one for normal operation and one for standby. The pumps are mounted on the scrub hold tank with remote disconnects and are located in the off-gas cell so that remote replacement is possible. They are a sump-type pump, capable of delivering approximately 120 gpm at 65 psig. The scrubbing solution could contain up to 5% solids. The portions in contact with the scrubbing solution are fabricated of Nitronic 50 for corrosion resistance. Alarms are provided for high pump-bearing temperatures (e.g., T208-1-1C) and low pump-discharge pressure (e.g., P208-1-1C).

2.6.2.2.9 Scrub Solution Cooler (HE-NCC-332)—The purpose of the scrub solution cooler is to cool the scrub solution and remove the heat absorbed in cooling the off-gas. This component is a shell-and-tube heat exchanger designed for a pressure of 150 psig and is fabricated of Nitronic 50.

The flow of cooling water (and the temperature of the scrub solution) through the cooler is controlled on the basis of the off-gas temperature (T111-1C) on the venturi scrubber KO drum. The scrub solution temperature is monitored (T332-1C) and alarmed for high temperature. The operating parameters follow:

Duty	1,480,000 Btu/h
Scrubbing solution flow	~ 85 gpm
Scrubbing solution inlet temperature	149°F (65°C)
Scrubbing solution outlet temperature	104°F (40°C)
Maximum scrubbing solution pressure drop	3 to 10 psi
Cooling water inlet temperature	25°C
Cooling water outlet temperature	40°C
Maximum cooling water pressure drop	10 psi
Corrosion allowance	1/8 in. (minimum).

2.6.2.2.10 Ruthenium Adsorbers (VES-NCC-112, -113, and -114)—Volatile ruthenium compounds are removed by three parallel adsorbent beds, each containing approximately 8000 lb of silica gel. The design off-gas velocity through each bed is 0.4 fps. A DF of between 2 and 4 for particulate and 1×10^3 and 5×10^3 for ruthenium is expected from the adsorbers. In addition to ruthenium compounds and particulate, the adsorbers collect hydrocarbons. Because hydrocarbons poison the beds for ruthenium adsorption, each bed is divided into two sections: an initial section, approximately 2 ft deep, to collect solids, hydrocarbons, and other organic materials and a second section, approximately 64 in. deep, for ruthenium adsorption. Each adsorber has systems to wash and dry the adsorbent, to remove old adsorbent, and to add new adsorbent. Each adsorber has manifolds and isolation valves to distribute the off-gas to the adsorber beds. An off-gas piping bypass around the adsorbers also is provided.

Any two of the three adsorbent beds are capable of handling the total NWCF POG flow while the third bed is being washed or replaced during calcining operations. However, if leakage of the adsorber isolation valves during washing could cause a significant risk of wetting and breaching of the off-gas HEPA filters, all of the adsorbers may be bypassed. This decision can be made only by INTEC management.

When calciner bed dissolution operations are performed, at least one adsorber bed is on-line and the off-gas system is operating.[33] The nitric acid concentration is controlled to minimize ruthenium releases by volatilization.

The adsorber vessels are fabricated of Type 304L stainless steel, designed for a pressure range of 30 psig to 7.5 psig vacuum with a 1/16 in. (minimum) corrosion allowance. Each vessel has a manhole, an adsorbent support grid, an adsorbent wash solution addition line, a wash solution drainline, a steam coil for drying the adsorbent, and an off-gas inlet and outlet line. The adsorbers are equipped with pressure relief valves. Valves are provided on the upstream side of the vessels to control flow to them. The vessels are provided with spray heads for the purpose of decontamination. Bed temperature is monitored (e.g., T112-1AC through T112-1EC) and has a high temperature alarm at 250°F (121°C).

Solutions for washing the adsorbers are made up in the decontamination solution tanks.

2.6.2.2.11 Mist Collector (VES-NCC-116)**—**The adsorber system is followed by a mist collector that collects moisture that may be carried over from the adsorbers. The vessel is fabricated of Type 304L stainless steel and designed for a pressure range of approximately 30 psig to 7.5 psig vacuum and a minimum corrosion allowance of 1/16 in. The mist collector has irrigating and flushing nozzles, a decontamination system (spray nozzle), and pressure taps for measuring the pressure drop across the element. A DF of between 1.5 and 4 is expected from the collector. The collector is equipped with a high liquid level alarm (L116-1C) and a high pressure drop alarm (PD116-1C). Additional operating parameters follow:

Off-gas flow	2650 cfm gas
Off-gas pressure	6.7 psia (154 in. of W.C.)
Off-gas temperature	167°F (75°C)
Maximum pressure drop	3 in. of W.C.

2.6.2.2.12 Off-Gas Heaters (HE-NCC-334 and HE-NCC-335)**—**The off-gas system requires two heaters. The first heater (HE-NCC-334) warms the off-gas before it goes to the adsorber beds. The second heater (HE-NCC-335), located between the mist collector (VES-NCC-116) and off-gas HEPA filters, heats the off-gas to prevent condensation in the filter housings. The material of construction for the two heaters is Type 304L stainless steel except the tubes of the first heater, which are constructed of Nitronic 50.

The ruthenium adsorbent material removes volatile ruthenium compounds best when the temperature is just a few degrees (41 to 50°F [5 to 10°C]) above the dewpoint. The first heater (HE-NCC-334) may be used to provide a 68°F (20°C) temperature increase to 1515 scfm of off-gas containing 36% water vapor. The steam jacket is designed for a pressure of 150 psig at 356°F (180°C) and fabricated of Type 304L stainless steel. The outlet off-gas temperature is continuously monitored.

The second reheater (HE-NCC-335) heats the off-gas to prevent condensation in the filters or their housings. The heater is designed to use 35 psig steam to provide a 68°F (20°C) temperature increase to 2015 scfm of off-gas containing 28% water vapor. The steam jacket is designed for a pressure of 150 psig at 356°F (180°C) and is fabricated of Type 304L stainless steel. The inlet and outlet off-gas temperature also is monitored on the second heater.

2.6.2.2.13 Off-Gas Filters (F-NCC-130-1, -2, -3, and -4)**—**Final cleanup of the off-gas is accomplished in four remotely maintained parallel filter units. Each filter unit or plenum contains one removable prefilter stage in series with two removable HEPA filter stages. DFs of between 2 and 5 for the prefilters and 4×10^5 and 1×10^7 for the HEPAs (for particulate) are expected. Each filter housing is constructed of Type 304L stainless steel and designed for an operating pressure range from -6.75 to +6.75 psig at 347°F (175°C). The two stages of HEPA filtration in each housing are provided with systems to ensure thorough aerosol mixing for an adequate in-place filter test. The filter housings are permanently installed and are equipped with a decontamination system (spray nozzle). Prior to being placed in service, each HEPA filter and filter housing must pass an in-place aerosol test. Aerosol injection and sampling stations are provided so that each HEPA filter can be independently aerosol tested. The filter units are designed so that (1) each stage of a filter bank may be remotely and independently replaced, (2) the pressure drops may be individually measured, (3) the flows may be individually measured, and (4) the housing temperatures may be monitored during replacement and startup. Each of the filter units is provided with a set of isolation valves to isolate each unit from the rest of the units. The filter housings have insulation (covered with a stainless steel sheathing) to prevent condensation from the off-gas. The differential pressure instruments (PD130-1-1C through PD130-4-1C), are monitored on the DCS, and will alarm upon high pressure drop across the filters.

2.6.2.2.14 Off-Gas Blowers (BLO-NCC-243-1 and -2)—The vacuum in the POG and vessel vent systems is maintained by one of a pair of off-gas blowers in parallel service. The second blower is an in-line spare. The blowers are comprised of four-staged compressors. The compressors require the KO drums for liquid removal. The blowers are constructed of Type 304L stainless steel and equipped with a decontamination system (1"-DCAF-4304). The operating parameters follow:

Gas flow (operating capacity)	2014 scfm
Average molecular weight	25.8
Inlet gas temperature	194°F (90°C)
Inlet pressure	5.2 psia (197 in. of W.C.)
Outlet pressure	12.6 psia.

Axial and radial vibration monitors, which are attached to the blowers, alarm before unacceptable vibration levels are reached. Excessive vibration could damage a blower's impeller and seals.

2.6.2.2.15 Off-Gas Blower Intercooler and Knockout Drum (HE-NCC-343-1 and -2, and VES-NCC-143-1 and -2)—The off-gas blower intercoolers cool the off-gas after it has passed through several stages of the compressors. Each compressor has its own intercooler. Construction material for the coolers is Type 304L stainless steel. Capacity of the coolers is 4,415,000 Btu/h.

Any mist left in the off-gas after passing through the coolers is removed by the KO drums (VES-NCC-143-1 and -2). The material of construction for the drums was Type 304L stainless steel. Alarms are provided for high liquid level (L143-1-1C and L143-2-1C), high temperature (T343-1-1C), and low temperature (T-343-2-1C).

A cooler and drum are connected to form one unit. The unit is provided with a spray nozzle for decontamination purposes.

Inservice off-gas passes from the blower through the cooler and drum, back through the blower, and then on to the APS.

2.6.2.2.16 Auxiliary Off-Gas Blower (BLO-NCC-242)—During a shutdown of the calcining system, the auxiliary off-gas blower maintains a vacuum on the off-gas cleanup system. When this blower is used, the intercooler (HE-NCC-341-1 and -2) and KO drums (VES-NCC-143-1 and -2) are bypassed. The blower is constructed of Type 304L stainless steel. Capacity of the blower is 990 scfm. Provisions were made so that decontamination solution may be introduced into the blower and drained away (1"-PLAD-2370). The design pressure drop of the blower is 1.5 psi. A blower bypass valve (HV-242-6) is installed around the auxiliary off-gas blower to prevent system pressurization if the compressors (BLO-NCC-243-1 and -2) and the auxiliary off-gas blower fail.

2.6.2.3 Off-Gas Treatment Control.

2.6.2.3.1 Control of POG Treatment System—The calciner vapor space is maintained at about 42 in. of W.C. vacuum by adjusting a combination of manual and automatic controls. Course adjustment is achieved by adjusting a butterfly valve (HV-243-1) in the suction line of the off-gas blowers. This is accomplished from the control room via H243-1C. Once the course adjustment is attained, fine adjustments are automatically maintained via the signal from the pressure tap (1/2"-LIAF-1831) in the top of the calciner vessel. The pressure signal (PT-105-1) is used to control the calciner vessel vacuum by adjusting the amount of air that is allowed to bleed into 4"-VGAD-2022. The 4 in. vent line is connected to the quench tower (VES-NCC-109). Adjustments to the quench tower pressure cause corresponding changes throughout the off-gas cleanup system and the calciner vessel. Thus, an increase in the bleed airflow rate into 4"-VGAD-2022 causes the calciner vacuum to decrease, i.e., approach a positive pressure. If too much plant air from ½"-LANC-3903 is allowed to enter this control system, a high-pressure alarm (P105-1C LO) activates at 30 in. of W.C. vacuum; a high-high alarm (P105-1C LOLO) activates at 20 in. of W.C. vacuum.

2.6.2.3.2 Control of VOG Treatment System—The vent gas from all vented vessels at the NWCF is treated before being released as a part of the off-gas stream. The various vent lines are all manifolded to line 6"-VGAD-2019. The combined streams then enter a vent condenser (HE-NCC-336). This heat exchanger has a capacity of 4.72×10^5 Btu/h. The purpose of the condenser is to remove condensables from the VOG stream.

After leaving the condenser, the VOG stream enters the vent condenser KO drum (VES-NCC-136). This vessel is designed to knock out any mist that is being carried over in the VOG stream. Condensed material drains from the bottom of the vessel via line 1"-PSAD-2017. This line drains to the scrub hold tank (VES-NCC-108).

After leaving the KO drum, the VOG stream then joins the POG stream just ahead of the mist collector (VES-NCC-116). From here, the VOG becomes part of the POG.

Pressure in the VOG system is controlled by a pneumatically operated valve (PV-22-1) in line 6"-PSAD-2009. This valve receives its control signal from a pressure indicator-controller (P122-1C) connected to a pressure-sensing element on the nonfluoride hot sump tank (VES-NCC-122). In addition, the system is provided with a flow-sensing device (F136-1C) and a temperature-sensing device (T136-1C). The indicators and alarms for these devices are located in the control room.

The pressure differential across the mist breaker of the vent condenser KO drum is monitored by PD136-1C. Inlet temperature to the KO drum is monitored by T336-1C, and the liquid level in the KO drum is monitored by L136-1C.

2.7 Safety Support Systems

2.7.1 Equipment

In general, NWCF equipment is designed for high reliability and for simplicity of operation and maintenance. The use of equipment with moving parts subject to frequent maintenance is minimized. However, some equipment with high maintenance frequencies are used and, in these cases, backup spares are provided. Corrosion resistance is also a prime consideration in selecting equipment and methods of construction for the NWCF. Selection was based on suitability for process service and compatibility with decontamination solutions. Decontamination solutions may be more corrosive than process solutions. However, considering the relatively short duration of contact with the decontamination solutions, relatively high corrosion rates can be tolerated during decontamination operations. In fact, removal of several mils of metal from the process equipment is one of the most effective methods of decontamination. Polymer materials are poorly suited to high radiation service (> 10^9 rads) and are generally not used in areas associated with high radiation fields.

The filter drying vessel, the filter leaching vessel and its associated sparge lines, steam lines, and piping are constructed of 300 series stainless steel. The filter leaching vessel design temperature is 250°F. The filter drying vessel design temperature is 500°F with an operating temperature of approximately 250°F. The filter leaching vessel materials are compatible with a leach solution of nitric acid.

The calciner vessel and cyclone are constructed of stainless steel on the basis of performance of this material with decontamination solutions. All of the components of the off-gas cleanup system and the feed system that are exposed to scrub solution are constructed of Nitronic 50 because of its superior corrosion resistance to the hot (176°F [80°C]) 4 M nitric acid solution containing fluoride ions. The 4 M nitric acid is obtained by dilution of fresh 13 M nitric acid stock or < 13 M low-level radioactive nitric acid from the nitric acid recycle system. The nitric acid recycle system is constructed of Type 304L stainless steel except for the acid recycle tank (VES-NCR-171), which is Type 304.

Abrasion resistance was another important criterion for specific NWCF equipment items. This quality was important in several areas to withstand the abrasiveness of the calciner product. The materials used to provide this quality and the areas of use follow:

1. Haynes 25 stainless steel for calciner feed and fuel nozzle caps.

2. Armco 17-4 PH (H-1050) or 17-7 PH for some valve plugs and valve trims.

3. Nitronic 50 stainless steel reinforcing at bends for calcine solids product takeoff and transfer lines.

Process piping and valves in cells not exposed to corrosive fluoride solutions as well as vessels and piping that can become contaminated as a result of an "upstream" failure are fabricated of Type 304L stainless steel, which has demonstrated satisfactory corrosion resistance in the NWCF. Vessels and piping located in nonradioactive areas and not in corrosive service are fabricated of carbon steel.

The feed control valves are located in the flowmeter cubicle. They are installed in remotely removable jumpers so that they can be easily removed for maintenance using a manipulator. Process block valves in the cells are pneumatic piston-operated shutoff valves, which are free of pockets and remotely operated by switches on the main control board. Each valve has a position indicator. The valves are equipped with packing resistant to the radioactive and corrosive properties of the process fluid and the decontamination solutions. Valve stems and pressure-containing parts are protected from the decontamination fluid by stainless steel shrouds.

Vessels were designed in accordance with the guidelines set forth in ASME Code Section VIII, Division 1.

2.7.2 Instrumentation

NWCF instruments are used to control and monitor both the H&V and process systems and to detect radiation hazards.

Sensing devices in the field (i.e., elements, transmitters, and switches) are installed for minimum exposure to radiation. Significant design effort was expended to locate as many field-mounted instruments as possible in locations where they would neither be exposed nor create unnecessary radiation hazards to operations or maintenance personnel. This was achieved by the use of (1) purged diptubes for level, density, and pressure sensing; (2) purged transmitters for flow and differential pressure; (3) transmitters with shielded low-level signals in hot cells and their amplification and adjustment sections located in the operating corridors. TCs in the calciner temperature rake are replaceable from the access corridor. Most other in-cell TCs and resistance temperature detectors (RTDs) are provided with dual element outputs to a transmitter outside the cell.

Several transmitters are housed in stainless steel cabinets in the operating corridors. Material from any leakage within these cabinets drains from a catch basin at the bottom of the cabinet, back into the cell, and eventually to the fluoride hot sump tank.

Power to the DCS is backed by a standby uninterruptible power supply (SUPS). The SUPS can provide backup power for at least 20 minutes from storage batteries. The SUPS can be powered or recharged from the standby generator.

2.7.3 Distributed Control System

Overall control of the NWCF is maintained from one control point, the control room, by means of a DCS. The DCS consists of several subsystems that operate simultaneously and independently to provide redundancy on critical systems.

The NWCF is controlled by a "MOD 300" DCS. The DCS is a microprocessor-based plant automation and information management system. The DCS is constructed of several individual subsystems (nodes). Each subsystem is a stand-alone computer, complete with one or more microprocessors, memory, power supply, etc. Critical subsystems have a backup microprocessor and multiple power supplies to provide redundancy in the event of a failure. By distributing control capabilities throughout several subsystems, the DCS is a masterless design where no single failure causes the entire system to fail.

2.7.3.1 Hardware Component Description. Figure 2-13 provides a ring diagram of the DCS depicting the arrangement of the various subsystems. The following subsections describe the different subsystems as well as the distributed communications network (DCN), which links the subsystems together. The final subsection describes the SUPs used to power each subsystem.

2.7.3.1.1 Configurator Data Processor Subsystem—The configurator data processor subsystem (node 01 in Figure 2-13) has a single microprocessor, a nonredundant power supply, dual DCN interface cards, a disk controller card, a serial interface card, disk drives, and a tape drive. The primary functions performed by the configurator data processor include the following:

1. Providing operating system boot files for all subsystems.
2. Monitoring and logging all self diagnostics generated by the system.
3. Providing vendor tools for generating new software.
4. Tracking configuration changes made to existing software.

5. Generating and archive printed reports.

6. Providing nonvolatile data storage to disk and tape.

2.7.3.1.2 Universal Gateway Data Processor Subsystem—The universal gateway data processor subsystem (node 02 in Figure 2-13) has a single microprocessor, a nonredundant power supply, dual DCN interface cards, an ethernet driver card, and a serial interface card. The primary functions performed by the universal gateway data processor include the following:

1. Providing data links with the waste processing computer system

2. Providing data links with diesel storage tank monitoring system.

2.7.3.1.3 History Data Processor Subsystem—The history data processor subsystem (node 03 in Figure 2-13) has a single microprocessor, a nonredundant power supply, dual DCN interface cards, a disk controller card, disk drives, and a tape drive. The primary functions performed by the history data processor include the following:

1. Archiving all process instrument readings

2. Archiving all instrument alarm activities

3. Archiving all operator control actions

4. Archiving all system access requests

5. Providing statistical process control capabilities

6. Providing nonvolatile data storage to disk and tape.

2.7.3.1.4 Controller Subsystems—The controller subsystems are designed for high reliability and have redundant components with automatic switch to backup. Each controller subsystem provides input signal conversion, control algorithms, alarm management, logic interlocks, and output signals for the portions of the plant connected to that subsystem. The DCS has four different controller subsystems connected to control different areas within the NWCF.

The first controller subsystem (node 04 in Figure 2-13) has 10 primary microprocessors, a backup microprocessor, redundant power supplies, and redundant DCN interface cards. This subsystem supports 160 analog input signals, 80 analog output signals, and 400 digital signals. This subsystem is wired to instrumentation controlling the calcination process, but not the calciner off-gas blowers.

The second controller subsystem (node 05 in Figure 2-13) has 10 primary microprocessors, a backup microprocessor, redundant power supplies, and redundant DCN interface cards. This subsystem supports 160 analog input signals, 80 analog output signals, and 400 digital signals. This subsystem is wired to instrumentation controlling the calciner H&V system, plus instrumentation from the calciner off-gas blowers.

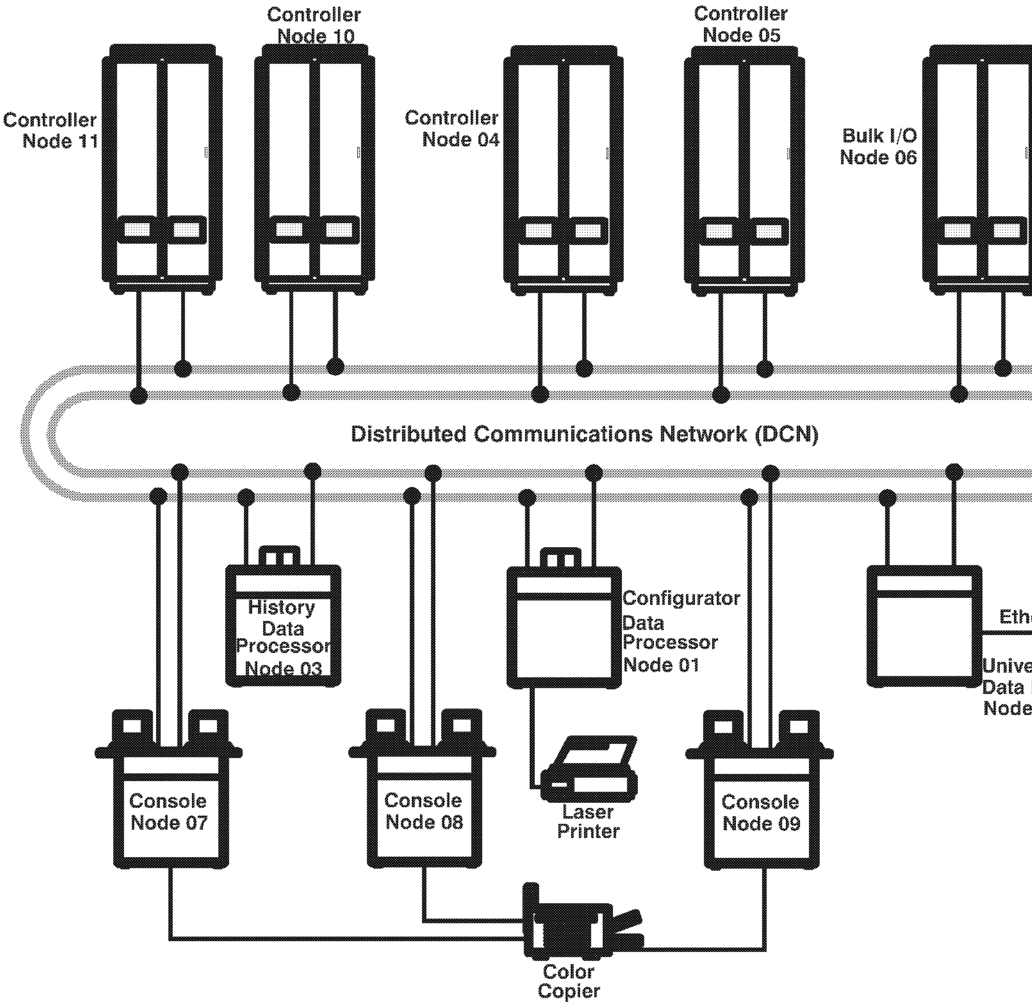

Figure 2-13. Distributed control system.

The third controller subsystem (node 10 in Figure 2-13) has three primary microprocessors, a backup microprocessor, redundant power supplies, and redundant DCN interface cards. This subsystem supports 48 analog input signals, 24 analog output signals, and 120 digital signals. This subsystem is wired to instrumentation controlling the HLLWE.

The fourth controller subsystem (node 11 in Figure 2-13) has one primary microprocessor, a backup microprocessor, redundant power supplies, and redundant DCN interface cards. This subsystem supports 16 analog input signals, eight analog output signals, and 40 digital signals. This node was added to allow additional instrumentation from the operating corridors to be connected to the DCS after existing spare wires to the control room had been utilized.

2.7.3.1.5 Bulk Input/Output Data Processor Subsystem—The bulk input/output (I/O) data processor subsystem (node 06 in Figure 2-13) has a single microprocessor, nonredundant power supplies, dual DCN interface cards, remote I/O local area network (LAN) cards, and high density I/O cards. The function of the bulk I/O processor subsystem is to provide lower cost input signal conversion, alarm management, and output signals than are available using controller subsystems. The bulk I/O does not provide redundancy and is intended for process instruments that are not essential for plant operation.

2.7.3.1.6 Console Subsystems—The DCS has three separate console subsystems (nodes 07, 08, and 09 in Figure 2-13). Each console subsystem has a single microprocessor, a nonredundant power supply, dual DCN interface cards, dual video driver cards, and a serial interface card. Each console subsystem also is equipped with two video monitors with touchscreens and keyboards. All plant operations can be completed from any one of the six console monitors. The primary functions performed by the console subsystems include the following:

1. Providing human-machine interface for DCS operations
2. Providing access control through passwords and security keys
3. Providing alarm annunciation, display, and prioritization
4. Displaying graphical representations of process equipment
5. Displaying real-time and history-trended data
6. Processing operator command inputs.

2.7.3.1.7 Distributed Communications Network—DCS subsystems are linked together by a redundant DCN. The DCN comprises two token-ring networks based on the IEEE Standard 802.5.[34] Token passing between nodes provides a deterministic network. A deterministic network prevents data collisions, and ensures that each subsystem is given an opportunity to access the network.

Both DCN rings are simultaneously active and share the communication load. If either DCN ring fails, all communication traffic is automatically routed to the other DCN ring. Dual DCN rings allow a new subsystem to be added on-line by connecting the new node to one ring at a time.

2.7.3.1.8 Standby Uninterruptible Power Supply—The SUPS is composed of a rectifier, an inverter, a static switch, and a battery bank, which are described in the following paragraphs.

The rectifier, or battery charger, operates on a three-phase ac input voltage of 120/208 Vac with a frequency of 60 Hz. The rectifier is capable of supplying the inverter's total input current when the inverter is fully loaded, and still having enough power to recharge the batteries in 8 hours to 95% of their rated capacity. The rectifier is equipped with circuit breakers on the ac input and the dc output. Power (ac) to the rectifier is supplied from a standby ac power source, which permits the SUPS to be powered or recharged from the standby generator.

The static inverter is a completely solid state device designed to provide 100% of the rated load continuously and 125% of the rated load for 30 minutes. The inverter supplies an output of 120/208 Vac with a frequency of 60 Hz for all input dc line and ac output-load variations. The inverter is equipped with a dc-input circuit breaker.

The static transfer switch is a solid state, three-pole device rated at 125% of the rated current continuously and 100% for one cycle. The static transfer switch has a make-before-break design to minimize disturbances to the load upon transfer and retransfer operations. Any single interruption will not exceed one-fourth of the cycle. The switch will transfer the load to the bypass supply if the inverter loses its source of power, a load overcurrent condition exists, or the switch is transferred manually. The switch normally transfers the load back to the inverter 30 seconds after the condition that caused the transfer is corrected.

The battery bank is rated at 120 Vdc with a 240 amp-hour capacity. The sealed battery cells contain a lead-calcium alloy with a completely gelled electrolyte in a plastic case. The battery cells are designed for a very low hydrogen gas emission, and require no special ventilation. The battery bank can provide power to all SUPS supplied equipment for a minimum of 20 minutes.

2.7.3.2 DCS Configuration Control. The NWCF DCS is considered to be a plant process computer system. The management control procedure (MCP) manual establishes the responsibilities and specifications for providing configuration control for all INTEC process computer systems.[35]

As specified in the MCP manual, a computer system configuration management plan (CSCMP) has been approved for the NWCF DCS. In accordance with the MCP manual, configured item lists are maintained for hardware and software installed on plant process computer systems. The configured item lists detail the quality level (QL) and date of the last revision for the items on the DCS. The date stamp showing the date of last modification is automatically generated by the DCS whenever any item of software is modified.

Hardware and software components of the NWCF DCS that implement or could compromise the function of process safety instrumentation (see subsection 4.4.5) and the RSS (see subsection 4.4.6) are assigned a QL of 2. Components that do not compromise the function of process safety instrumentation are assigned a QL of 3.

The MCP manual specifies a graded approach for configuration control associated with hardware and software components of plant process computer systems. The proprietary software language is similar to C language. The level of approval and the testing specified for changes to items with a QL of 2 is more rigorous than specified for changes to items with a QL of 3. This graded approach ensures that the function associated with items with a QL of 2 is not compromised.

2.8 Utility Distribution Systems

2.8.1 Utility Power System

Electrical power is normally supplied to the NWCF from the power distribution system (132 kV loop) for the INEEL.

A 5 kV feeder with a capacity of 2000 kVA and a maximum 2% voltage drop was installed from the 2.4 kV switchgear in building CPP-675 to the 2.4 kV switchgear in the NWCF. Only one source of normal utility power is needed for this facility.

A suitable 2.4 kV switchgear cubicle, with an air circuit breaker, the associated meters, and protective relays, was installed adjacent to existing 2.4 kV switchgear at CPP-675.

The distribution system for all building loads, except the off-gas blowers and fluidizing air electric heaters, is 277/480 V and 120/208 V, three-phase, and four-wire grounded. Ground fault protection is provided in accordance with the National Electrical Code (NEC). The off-gas blowers are connected to a 2400 V, three-phase system. The electric heaters are connected to a 480 V, three-phase, ungrounded system. A ground detector with an indicating light and audible alarm is provided for the ungrounded 480 V distribution system.

The NWCF switchgear is a 5 kV indoor metal-clad type, rated at 250 MVA, with 1200 A electrically operated air circuit breakers and manually operated fused-air switches.

A pad-mounted 2400/480 V, 3-phase, 60 Hz, oil-filled transformer (XFR-122) is located inside the NWCF transformer yard. The dry-type transformer is provided with standard indication and alarm accessories, including a pressure-vacuum gauge and a sudden-pressure relay, in accordance with National Electrical Manufacturers Association (NEMA) specifications. Dry-type transformers are used for indoor service.

The 480 V, three-phase motor control centers (MCCs) have a 600 A main bus and are the indoor type. Motor starters are the combination circuit breaker type with suitable 480/120 V control transformers. In general, starters are the full-voltage type. Each starter has overload relays with an externally operated normal reset button. Overload heaters are sized for full-load current with consideration of the motor service factor and the starter enclosure ambient temperature.

2.8.2 Standby Power System

A 2400 V diesel-powered generator (GEN-NCM-440-1) rated at 1250 kVA is located in the NWCF standby generator room. Standby loads are supplied by components that have power backup to ensure their availability in the event of a utility power failure. In the normal operating mode, these loads are fed from utility power service. If a power failure occurs, a signal from utility power starts the standby generator. When 2400 V is reached, an electrically operated air circuit breaker closes and supplies power to the required loads.

The automatic transfer from normal power to standby power and the subsequence manual return to normal power will cause an interruption of service of approximately 15 seconds to all loads connected to this system, except for those systems that have their own uninterruptible power source (UPS). Portions of the 2400 V system (PCC-NCM-268) have been provided with ground fault circuit interruption (GFCI) protection. This GFCI protection prevents equipment damage and protects personnel in the event of a failure of a transformer (XFR-NCM-122, -123, -124, or -125). The GFCIs would open before the NWCF substation breaker would open, and thus prevent a total loss of power at the NWCF.

The ventilation blowers, instruments, and certain essential equipment are arranged to restart automatically in a preset sequence; lighting and alarm circuit breakers remain closed through an interruption of service.

Table 2-39 lists the essential loads that are served from the NWCF standby system in the event of loss of normal power.

Standby power is arranged to start automatically or manually upon loss of normal power. However, an adjustable time delay of 3 to 30 seconds is provided after bus voltage has decreased to 70% of its normal value. This prevents startup of standby power during momentary voltage dips that are caused by transient disturbances or system transfers. When the generator attains its normal voltage and frequency, the control scheme is arranged to automatically energize selected essential loads in sequence. Additional essential loads are energized manually at the discretion of NWCF operating personnel. Transfer of a load from standby to normal supply is manually initiated. Manual start and bus synchronization provisions are made for periodic load-testing of the generator.

A second 2400 V diesel-powered generator (GEN-NCM-440-2) rated at 1250 kVA also is located in the NWCF standby generator room. The standby loads served by this generator consist mainly of components located at the FAST, RAL, CPP-697, the LET&D facility, and the deepwell pumps. The standby generator will start in an automatic mode on a power failure at either the FAST or the RAL facility. A time delay prevents the generator from startup during momentary voltage dips caused by transient disturbances. An annunciator in the NWCF control room signals upon generator startup.

When 2400 V is reached, electrically operated circuit breakers close, and the required loads are supplied with power in a sequenced manner. (The deepwell pumps are manually added by the closure of a local breaker. If a power failure to only the deepwell pumps occurs, the generator is manually started and the local breaker is closed to furnish power to the pumps.)

With the second generator (GEN-NCM-440-2), the transfer of a load from standby to power supply is automatically initiated. Manual start and bus synchronization provisions are provided for periodic load testing of the generator.

Seismic qualification was accomplished in accordance with the procedures outlined in IEEE Standard 344-1975, which include the following qualification methods: (1) mathematical analysis, (2) testing under simulated seismic conditions, and (3) testing and analysis.

The following equipment and electrical systems were qualified to withstand the DBE:

1. Standby generators (GEN-NCM-440-1 and -2).

2. Standby electrical distribution system: 2400 V switchgear (PCC-NCM-268), 480/2400 V transformers (XFR-NCM-123, -124, -125, and -126), standby MCC (EMCC-NCM-272) and the room lighting station, 120/208 V power panel (EPCC-NCM-277) for the central control panel and process instruments; and a station battery with an automatic battery charger (STA-NCM-300).

Equipment descriptions for the generators are provided in Idaho Nuclear Technology and Engineering Center Plant Safety Document (PSD) Section 4.1.[36] The equipment that is supplied with power by the second standby generator (GEN-NCM-440-2) is tabulated in the safety analysis reports for the FAST and RAL facilities.[37,38]

Table 2-39. NWCF loads on standby power.

Equipment or Facility	Full Load (kVA)	Estimated Load (kVA)	Units Running
Calciner supply blowers (BLO-NCM-271-1, -2, and -3)	75 + 75	53 + 53	2
Calciner exhaust blowers (BLO-NCM-285-1, -2, and -3)	97 + 97	71 + 71	2
CAM vacuum blowers (BLO-NC0-250-1 and -2)	30	23	1
Switchgear room exhaust blowers (BLO-NCM-281-1 and -2)	2	2	1
Scrub recycle pumps (P-NCC-208-1 and -2)	21	16	1
Brine supply pumps (P-NCE-285-1 and -2)	21	16	1
Fluidizing air blowers (BLO-NC0-205-1 and -2)	41	32	1
Brine chillers (AC-NCE-783-1 and -2)	156	121	1
Decontamination exhaust blowers (BLO-NCD-287-1 and -2)	75 + 75	68 + 68	2
Kerosene pumps (P-WDS-3305-A and -B)	5	4	1
Generator fuel pumps (P-NCM-240-1 and -2)	0.5	0.5	1
Off-gas blowers (BLO-NCC-243-1 and -2)	374	285	1
Dilution air heaters (HTR-315-1 and -2)	3	---	1
Motive air heaters (HTR-307-1 and -2)	11	---	1
Fluidizing air heaters (HTR-305-1 and -2)	175 + 90	---	2 startup 1 running
Miscellaneous and instruments	75	---	N/A[a]
Standby lighting (ELP-NCM-303)	68	68	N/A
Lube oil consoles (CON-NCC-943-1 and -2)	10 + 10	---	2
Control room blower (BLO-NCM-282)	5	4	N/A
Control room air conditioner (AC-NCM-782)	23	23	N/A

Table 2-39. (continued).

Equipment or Facility	Full Load (kVA)	Estimated Load (kVA)	Units Running
Decontamination vent blower (BLO-NCM-221)	1	1	N/A
Fourth CSSF	---	10	N/A
Fifth CSSF	---	65	N/A
Sixth CSSF	---	65	N/A
Generator room exhaust blower (BLO-NCM-280)	1	1	N/A
Isokinetic system (ISO-NCM-02)	1	1	N/A
Standby generator (GEN-NCM-440-1)	7	7	N/A
Scrub system exhaust blower (BLO-NCD-289)	10	7	N/A
Bearing lube pump (P-NCC-231)	0.5	0.5	N/A

a. N/A – Not applicable.

2.8.3 Remote Handling

Lighting fixtures, motors, and other electrical equipment are located in cells with shielding windows and manipulators. These fixtures, motors, and equipment are provided with hot cell type connectors and cable assemblies. The connectors and cable assemblies are designed for installation and removal by remotely operated manipulators and cranes.

2.8.4 Heat Tracing

Heat tracing was accomplished with standard industry-designed tapes and cables. Mineral-insulated cable was used in process cells where high temperatures and radiation are prevalent.

2.8.5 Lighting

The indoor lighting system operates from a 480/277 V, three-phase, four-wire supply. Area and flood lighting is supplied from a 480 V, three-phase, three-wire supply.

Panelboards for lighting, convenience receptacles, instruments, and power are located in the area served. The switches are mounted at a convenient height above floor level.

In general, panelboards have circuit breakers rated at 20 A for branch circuit protection. Initial loading does not exceed 80% of the circuit breaker rating. Provisions for future expansion were made in each panel on the basis of 30% bus capacity.

Feeders and branch circuits were sized so that the voltage drop from the transformer secondaries to the load does not exceed 5%.

Lighting fixtures are suitably arranged and spaced to provide adequate, uniform illumination and ease of relamping and maintenance. Lighting intensities in general conform to the recommendations outlined in the ERDA Manual, Appendix 6301.

Fluorescent fixtures are suitable for use with rapid-start lamps (T12). Ballasts for fixtures of 40 W or greater are Class P to meet the NEC[39] specifications and are provided with automatic reset thermal protective devices to limit the winding temperature to 102°C. Ballasts are high-power-factor type with Electrical Testing Laboratories Certified Ballast Manufacturers labels. For interior fluorescent lighting applications where the average ambient noise level is low, ballasts have a sound rating of A. This applies to all areas except equipment rooms.

Fluorescent lighting fixtures are used in the areas (office, control room, corridors, etc.) where there is continuous full-time personnel occupancy (40 hours per week). The fluorescent fixtures have prismatic lens and rapid-start lamps. Mercury vapor fixtures with color-improved lamps are used in high-bay areas and cells. Floodlights installed on exterior walls and light fixtures above exterior doors are of the mercury vapor type and are controlled by a time switch with a manual override.

In-cell illumination is designed for an effective, or as viewed, minimum illumination level (the product of the in-cell illumination level and the window transmittance) of approximately 20 footcandles. Mercury vapor with a soft glass, white phosphor coating is used as the normal light source. Reduced high-intensity lighting is provided for the occasions when direct maintenance is to be performed within process cells. The visibility inside a cell as viewed through a shielding window is improved by dimming the lighting outside the cell. A solid-state dimmer control on the lights is used for dimming. Provisions were made to permit in-cell lamp replacement from outside the process cells. Lamps with glass that will darken from irradiation are not used.

Incandescent fixtures were installed in small rooms and in areas that are used intermittently. All cells and cubicles are provided with a single incandescent fixture to provide illumination while the mercury vapor lights are coming up to power. Fluorescent and mercury vapor fixtures have 277 V ballasts; mercury vapor fixtures in cells have remotely mounted ballasts. Fixtures within the decontamination spray areas are waterproof.

Security lights are provided to adequately illuminate outdoor areas, building exteriors, fence lines, gates, and roadways. Mercury vapor fixtures are used for this purpose and are automatically controlled by individual or multiple-circuit switching devices.

Emergency lighting throughout the NWCF building is provided with two sources of power. Normally, the lighting is served from the utility ac system. Upon loss of utility ac voltage, integral battery packs automatically supply power for the emergency lighting. Fixtures automatically revert to ac voltage operation upon startup of the standby generator.

Lights in corridors and in the maintenance area are panel-switched. Light switches in cells have pilot lights. Emergency lighting at normal exit routes is provided by the fully automatic battery system.

The average levels of illumination listed are provided in Table 2-40.

2.8.6 Power and Welding Receptacles

Power and welding receptacles are provided throughout the plant as needed for specific services and for general maintenance.

Receptacles provide three-wire, four-pole, 480 V, 60 Hz, three-phase service. Current ratings are based on the equipment served.

2.8.7 Conduit and Raceway Systems

All electrical wiring except mineral-insulated cable is enclosed in suitable, adequately sized raceway systems such as rigid steel conduit, nonmetallic conduit, cable trays, and wireways.

All rigid steel conduit is hot-dip-galvanized or equivalent with threaded ends. The conduit and conduit fittings are specifically manufactured for electrical installation. The conduit inside the cells is stainless steel.

All overhead and underground conduit runs are rigid steel except as noted below. The minimum size of rigid conduit is ¾ in. except for connections to field-mounted instruments and devices, which are ½ in.

General lighting and other nonessential circuit runs are electrical metallic tubing in exposed conduits and in above-suspended ceilings of areas such as offices.

Table 2-40. Illumination levels for NWCF.

Area	Average Lighting Levels (footcandles)
Offices	50
Hallways	20
Process areas	30
Process and decontamination area corridors	20
Stairways	10
Switchgear and emergency generator rooms	20
Control room	100
Computer room	40
Decontamination areas	30
Maintenance area	30
H&V equipment rooms	10 to 20
Storage rooms	20
Elevator	30
Cells	60
Shower rooms and toilets	30
Emergency lighting	3
Main control panel	75
Individual panels	10 to 40
Entryways	30
Cubicles	30

Underground duct banks are encased in red-colored concrete and are adequately reinforced. Individual or isolated underground conduits are rigid steel. The minimum size of underground conduit is 2 in. Underground conduit and duct banks were installed at a minimum of 1.5 ft belowgrade.

Cable trays are fabricated of steel or aluminum. Steel trays are hot-dip galvanized after fabrication. The trays are 3 in. deep with punched-bottom or ladder-type construction.

Cable trays are installed and supported to withstand maximum possible cable and seismic loading, when needed.

Wireways are fabricated of sheet metal with hinged or removable covers. Conduit, bus duct, cable tray, and other raceways are sealed when penetrating specific walls and floors (critical air barriers).

2.8.8 Wire and Cable

2.8.8.1 Power, Lighting, and Control. Cable for service at 2.4 kV is stranded copper, single conductor, with ethylene propylene insulation, rated for 5 kV ungrounded service. The cable is shielded and has an overall jacket of polyethylene or polyvinyl chloride (PVC). The cable is suitable for power circuits in wet or dry locations in conduit or directly buried.

Copper conductor, with 600 V class moisture- and heat-resistant thermoplastic insulation, is used for cable for service below 600 V.

Conductor sizes no. 6 American wire gauge (AWG) and larger are stranded; no. 8 and smaller are solid.

The minimum conductor size for power and lighting is no. 12 AWG; no. 14 AWG is used for control or indication lighting wiring.

Cable is selected to coordinate with the power system short-circuit current magnitudes and protective device interrupting time to avoid damage to the cable insulation during fault conditions.

Feeders to load centers are sized for maximum transformer rating, including that which is obtainable by the addition of future forced-air cooling.

Multicolor copper, with 600 V class, color-coded insulation is used for control cable. Insulation is polyethylene with a PVC jacket and an overall sheath of PVC. Color coding was accomplished in accordance with Insulated Power Cable Engineers Association and NEMA standards.

Multiconductor, shielded, 600 V class insulation, with twisted pairs, is used for instrument control cable for connections from local junction boxes to central panels. Individual instrument connections to local junction boxes are of no. 16 AWG, shielded, twisted-pair cable with an overall PVC jacket. Colors are black for positive lead and white for negative lead.

2.8.8.2 Thermocouple Extension Wire. TC extension wire conductor material is the same as that specified for the TC. Limits of error are in accordance with ANSI Standard C96.1-1964. The insulation and jacket of the TC extension wire is polyamide film Type F. Insulation is color coded in accordance with ANSI standards.

Single TC extension cables are no. 16 AWG duplex pairs with a covering jacket. The duplex pairs are shielded and twisted. Multicolor TC extension cables are no. 16 AWG duplex pairs with a covering jacket. An overall shield and jacket covers all the duplex pairs.

Shielding is either tinned copper braid or aluminum-backed Mylar tape. If tape is provided for shielding, a solid bare copper no. 20 AWG minimum drain wire is provided for the full length of the cable. The drain wire is in contact with the metallic surface located inside the tape.

For twisted duplex wire, the maximum lay is 2 in. Individual pairs are twisted before being assembled into a cable.

TC extension wire was run continuously wherever possible. When needed, splices were made with insulated solderless connectors, each of which creates a positive junction by clamping two wires into intimate contact with each other.

TC extension wires are run in separate raceways from power, lighting, alarms, analyzer circuits, and resistance temperature detector leads.

2.8.8.3 In-Cell Wire and Cable. In-cell electrical wiring is subject to the combined effect of radiation and decontamination. Electrical wiring and equipment that are subject to high radiation are insulated in accordance with the level of radiation to be encountered. In areas where a high level of radiation is encountered, materials such as polyamide film (Kapton) are used. Other polymer materials are poorly suited to high radiation levels and were not used in the feed system and other such areas. The design of the wiring permits periodic replacement of conductors and equipment in high radiation areas to be accomplished with minimum personnel exposure.

2.8.9 Grounding System

A grounding system is provided to ensure the safety of personnel and equipment in case of electrical equipment failure and to limit excessive voltage from lightning and line surges. The system is designed and installed in accordance with the recommendations of the NEC.

A counterpoise made of no. 4/0 AWG stranded copper cable is provided around the building. The counterpoise lies within 5 ft of the building and between 2.5 and 5 ft belowgrade. The counterpoise is connected to the underground cold water piping system, which has suitable bonding jumpers provided at meters and insulated sections. The system neutrals are grounded at transformers only.

The following items are permanently and directly connected to the grounding system:

1. Motor and generator frames.

2. Transformer cases.

3. Noncurrent-carrying metallic parts of electrical equipment such as switchgear, MCCs, motor starter enclosures, panelboards, and pushbutton stations.

4. Exposed conductive material enclosing electrical conductors such as metallic conduit, metallic sheaths and shields, cable trays, cable racks, wireways, busways, and raceways.

5. Structural steel in buildings, exposed metallic structures, and stacks.

6. Mechanical equipment not directly bolted to a grounded supporting structure.

7. Lightning arresters and air terminals.

8. Overhead static lines on the pole line.

9. Wire fences and other metallic enclosures or barriers in the vicinity of electrical power lines and equipment.

A copper ground conductor with green-colored insulation is installed in all conduits for equipment grounds. Ground conductors are not looped between equipment. Connections to equipment are bolted.

2.8.10 Lightning Protection

Lightning protection for all structures and exposed equipment is provided in accordance with the requirements of ANSI Standard C5.1. The lightning protection equipment and installation was furnished with an Underwriters Laboratories (UL) Master Label C as described in the UL Electrical Construction Materials List.

2.8.11 Cathodic Protection

Underground piping is protected from corrosion by means of an impressed current cathodic protection system. The system consists of suitably rated rectifiers that supply direct current to the piping.

2.8.12 Acceptance Testing

The following acceptance testing was performed on equipment and materials in accordance with the manufacturer's instructions or standard industry practice:

1. Insulation-resistance testing of cables.

2. High-potential testing of cables.

3. Checkout and operation of electrical equipment (including standby generator).

4. Calibration and testing of protective relays.

5. Calibration of meters.

6. Dielectric testing of liquid-filled transformers.

2.9 Auxiliary Systems and Support Facilities

2.9.1 NWCF Compressed Air System Components and Operation

NWCF compressed air systems provide instrument, plant, and breathing air. The instrument and plant air systems are supplied by an air line connected to the existing INTEC compressed air main. The air line, containing air at 100 psig, enters the NWCF by way of the utility corridor. Before entering the second-level corridor, the line is split into a 100 psig, a 50 psig, and a 20 psig line. The 100 psig air is used as blast air and ejector driving air, as well as for maintenance service stations. Sparge and atomizing air is supplied by the 50 psig system. Airlifts and purges are handled by the 20 psig system.

The instrument air system draws air from the 100 psig plant air system. To provide enough instrument air for an orderly shutdown should the plant air supply fail, an air receiver is provided as part of the instrument air system.

Breathing air is provided by the CPP-606 breathing air system. The breathing air is connected to breathing air stations.

The system for supplying compressed air to the entire INTEC consists of three regular air compressors (COM-UTI-614, COM-UTI-615, and COM-UTI-617) located in CPP-606. The compressors are of a rotary screw type; the standby compressor is portable with its own diesel power and is located in CPP-616.

Two of the regular compressors (COM-UTI-614 and -615) are equipped for normal and standby power. Only one air compressor is actually on-line at any time. The compressor that is on-line is selected by the breaker selector switch to receive standby power. The standby air compressor (COM-UTI-616) is portable and has a diesel engine for its own power supply. If use of the standby air compressor becomes necessary, a drop in air pressure occurs. This may cause a partial interruption of the instrument air service at the NWCF.

2.9.2 NWCF Steam Supply and Distribution System

Steam needed for ejectors, process heating equipment, pipe tracing, equipment decontamination, sparging, and various other utility services is drawn from the existing INTEC steam main and delivered to the NWCF through an insulated line in the utility room. The nominal supply pressure is 150 psig. Steam is used at an average rate of 9500 lb/h; maximum usage in cold weather is about 20,000 lb/h. Full-pressure steam is distributed throughout the building for ejectors and for one heater. A pressure-reducing station (located in the utility room) provides 35 psig steam throughout the facility where low-pressure steam is needed for vessel sparging, equipment and systems cleanout and purging, heaters, jackets, and maintenance service stations.

The primary steam supply for the INTEC, including the NWCF is the Demineralized Water and Steam Generation and Distribution System.

2.9.3 NWCF Treated Water Supply

Process cooling water for the NWCF is supplied from the INTEC treated water supply system that serves the NWCF. Normal NWCF usage is approximately 100 gpm. Cooling water is supplied to the decontamination solution makeup tanks (VES-NCM-117 and -118).

The scrub solution cooler (HE-NCC-332) and the HLLWE condenser (HE-NCC-351) demand the largest portions of the cooling water (approximately 7000 gph each). The scrub solution cooler is considered the most important cooling system at the NWCF. The calciner POG temperature is controlled by regulating the amount of cooling water to the scrub solution cooler. A loss of cooling water to the scrub solution cooler would allow the off-gas temperature to increase beyond 158°F (70°C) where fluoride corrosion rates would rapidly increase. Continued operation under this situation would not be permitted, and an operator would correct the cooling water supply problem or shut down the calciner.

2.9.4 NWCF Sewage Treatment

All sanitary waste from the NWCF is routed to the main sewerline and then to the INTEC sewage treatment plant (CPP-715). This sewage system meets all DOE specifications.

This system is segregated from all process streams to minimize the probability of discharging any radioactive material.

2.9.5 NWCF Communications and Alarm System

A system of conduits, telephone outlets, and telephone terminal cabinets is provided at the NWCF for internal and external telephone communication. Standby power is provided for the telephone system to ensure internal and external communications during a loss of normal power. The minimum conduit size is ¾ in. A 200 pair telephone cable runs from the main telephone terminal in the NWCF switchgear room to the telephone room in the basement of CPP-602. A standard insulated copper wire is provided at the main circuit and is connected to the building electrical grounding cable.

A public address and two-way intercom system is provided for the NWCF. Standby power is provided for the two-way intercom system to ensure internal communications during a loss of normal power. Speakers are installed to provide full coverage of the facility including the exterior areas of the facility. Paging throughout the entire NWCF is possible from any telephone.

The warning and evacuation system consists of an electrically supervised manual control station, a control panel, and sirens. The system locally initiates and controls the warning and evacuation signals and activates the main INTEC evacuation alarm system. The sirens for this system are strategically located throughout the facility to provide complete coverage for all normally occupied areas. The evacuation system is independent of the fire alarm system and is backed by standby power via the NWCF diesel generator.

An electrically supervised, shunt, noninterfering, manual fire alarm system for the NWCF conforms to INTEC and Factory Mutual Research Corporation specifications. The fire alarm system is backed by its own battery system. The system consists of a coded transmitter, a control panel, manual fire alarm boxes, and bells located throughout the facility. The heat sensors, the smoke detector, and the explosimeter in the calciner cell H&V system are not tied into the fire alarm system. These items are connected to the DCS in the control room. The coded transmitter is capable of transmitting four rounds of signals when any uncoded fire alarm box within the facility is manually operated. Coded alarms are transmitted via telephone lines to the CFA fire station and the CFA communications room. Interface is accomplished through the main telephone circuit in the NWCF. Information from the CFA communications room is relayed to the WCC in Idaho Falls. A separate fire alarm code automatically is sent to the above areas when the waterflow switch in the wet-pipe system is activated by waterflow. A standby battery and battery charger automatically furnish the supervisory current during interruption of normal power.

Communication with the WCC in Idaho Falls is provided via the telephone system located in the NWCF control room.

All process alarm inputs have individual high- and low-alarm setpoints that can be stored in the memory of the computer data acquisition system.

2.9.6 NWCF Fuel and Oxygen System

Process heat needed for calcination of radioactive liquid waste in the calciner vessel is provided by in-bed combustion (IBC) of kerosene atomized with gaseous oxygen. Both kerosene fuel and oxygen are supplied to the NWCF from existing INTEC facilities. Kerosene is pumped from storage tanks through an underground transfer line serving the NWCF and is filtered prior to distribution to the calciner fuel nozzles. Fuel pumps deliver a maximum of 1 gpm at 70 psig and 60°F. The fuel system is installed in accordance with Occupational Safety and Health Administration (OSHA) and NFPA Standard 30 specifications.

Gaseous oxygen required for IBC is supplied from two tanks. Liquid oxygen is vaporized to provide up to 200 scfm (3000 gal/day) of gaseous oxygen at 21°C and 150 psig.

The gas pressure is reduced to a working level prior to distribution to the calciner fuel nozzles by a pressure-reducing valve (FV-105-10).

A volumetric ratio of oxygen to the fuel flow control system is provided to control the oxygen flow through each nozzle as a function of the fuel flow demand. An air purge line is connected to the fuel lines to each nozzle in the event of clogging.

In the event of an emergency shutdown, the fuel and oxygen supplies are automatically shut off by two valves located in each line and connected to the RSS. Gaseous oxygen is ensured by an automatic temperature control valve in the oxygen supply line. The supply line will shut off the flow of oxygen to the NWCF should the line temperature drop below 40°F.

2.9.7 NWCF Decontamination System

A remote means of decontaminating cells, equipment, and piping that have the potential of being contaminated by radioactive materials is provided for the NWCF. All equipment that is used to handle radioactive material has permanently installed decontamination lines and internal sprays. In addition, ceiling and wall-mounted decontamination spray headers for overall decontamination prior to personnel entry are installed in most process cells and the valve cubicles. Water, nitric acid, decontamination solution, purge air, or steam can be supplied to these systems through common manifolds for the removal of residual radioactive waste adhering to walls, crevices, and areas in and around the equipment. Two hot sump tanks are provided to receive the decontamination waste and process waste.

2.9.8 Decontamination Solution Supply System.

The decontamination solution supply system consists of two solution makeup tanks (VES-NCM-117 and -118), two decontamination solution pumps (P-NCM-217 and -218), manifold headers, and all associated valving and piping necessary to direct the decontamination solution to the process cells and equipment. This equipment is located in a radioactively cold area above the process cells in the NWCF. The elevated position, in conjunction with check and block valves in all lines feeding the cells and equipment, protects the system from backflow of radioactive materials from the "hot" areas.

Nitric acid (or a special decontamination solution) is received in the makeup tanks through line 1-1/2"-NAAF-4407 from CPP-602. Chemicals are added and mixed in the two tanks. Thus, either tank can supply nitric acid or decontamination solution to the distribution system.

Each storage tank has a capacity of about 1000 gal. A coil is provided in each tank for heating or cooling the contents. Motorized agitators (AG-NCM-417 and -418) are provided for stirring the solution in each tank. Vent gases from the tanks are drawn through a mist eliminator by a vent blower and are exhausted to the atmosphere.

Pumps transfer the solution from the tanks to the headers that supply the individual equipment and process cell decontaminating systems. The pumps also may be used to recirculate the solution through the tanks with the correct valve lineup.

The decontamination solution makeup area piping configuration ensures the availability of liquids from either of the two decontamination solution vessels as well as the availability of water, steam, and air. The north and south corridors are equipped with supply headers. For supplying decontamination solution to the equipment spray connections, lateral feeders extend from the supply headers into the cells. The lateral feeders have manual and automatic DCS-controlled valves, check valves, and purge piping, all located in the corridor. Another 1 in. lateral feeder into the cells has a hose connection for manual decontamination of equipment, and a 2 in. lateral feeder into the cells and cubicles connects to a ceiling and wall-mounted room spray system.

2.9.8.1 Decontamination Solution Collection and Recycle System. All radioactive waste solutions from NWCF equipment, cells, and cubicles drain by gravity to one of two hot sump tanks. One tank is dedicated to the collection and temporary storage of waste solution containing no fluoride, the other to the collection and temporary storage of waste solution containing fluoride. With the phaseout of fuel reprocessing, very little fluoride remains in the waste to be calcined. The fluoride sump tank continues to receive the same process solutions even when they contain no fluoride.

Drains to the hot sump tanks run individually to liquid droplegs in the tank liquid and have reach-rod-operated ball valves. Drains from areas with a common atmosphere are manifolded.

Waste from the fluoride hot sump tank can be transferred by either pump or steam jet. Waste from the nonfluoride hot sump tank can be transferred by jet. Jet discharge lines contain check valves and are joined together. Waste to be reprocessed in the calciner is transferred through a line and remote control valve to the waste hold tanks. Waste to be processed in the PEW evaporator is transferred through a stainless steel, double-encased line and remote control valve to a header that enters the PEW evaporator feed tank. Waste returned to the waste Tank Farm is transferred back through the same line that brings waste feed to the NWCF.

Each hot sump tank is equipped with a heating and cooling coil, a sparge line near the bottom of the tank, a decontamination spray head system near the top of the tank, a sampling system, and a vent connection to the equipment vent system.

2.9.9 NWCF Feed Additive System

When calcining waste containing fluoride, calcium nitrate is added to the waste feed to prevent fluoride volatilization by forming calcium fluorozirconate. Calcium fluorozirconate decomposes to calcium fluoride during calcination to minimize fluoride volatility. In the NWCF, calcium nitrate can be added as a liquid or solid to the waste hold tanks. Liquid calcium nitrate can be received in the liquid calcium nitrate storage tanks (VES-NCM-134 and -135) or can be made up from solids in the calcium nitrate solution tank (VES-NCM-120). Solid calcium nitrate may be added to the waste hold tanks via a hopper (HO-NCM-846) and screw conveyor (CVR-NCM-446-1). Protection against backflow of radioactive materials from the "hot" areas is provided by check valves and block valves in the liquid solution transfer line. A low vacuum in the hold tank automatically closes this valve in the solids addition line to prevent possible backflow of contaminants and solids addition during low-vacuum conditions.

2.9.10 NWCF Bed Addition System

Bulk quantities of the calciner vessel startup bed material, dolomite [$CaMg(CO_3)_2$], are stored in room 427. A hopper is used for the transfer and addition of dolomite. A fixed port is provided to facilitate dolomite addition from the maintenance area above the calciner cell. The dolomite flows by gravity into the calciner vessel.

The port for startup bed addition is equipped with a valve and a cam lock cap that are closed and installed respectively at the conclusion of bed addition to prevent the backflow of radioactive material from the calciner vessel during normal operation. In addition, the calciner vessel is operated at a negative pressure to ensure against the backflow of radioactive material to the startup bed addition hopper.

2.10 Drawings

Current copies of the NWCF drawings are maintained by engineering document control.

2.11 References

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