FINAL SAFETY ANALYSIS REPORT

SAVANNAH RIVER SITE

DEFENSE WASTE PROCESSING FACILITY

JULY 2015

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PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-09SR22505

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REVISION STATUS

CHAPTER	AFFECTED SECTIONS	REVISION	DATE
1	All Sections	34	7/2015
2	All Sections	34	7/2015
3	All Sections	34	7/2015
4	All Sections	34	7/2015
5	All Sections	34	7/2015
6	All Sections	34	7/2015
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10	All Sections	34	7/2015
11	All Sections	34	7/2015
12	All Sections	30	7/2011
13	All Sections	34	7/2015
14	All Sections	34	7/2015

DWPF FSAR REVISION LOG

Rev.	Date	Chapters Affected	Description of Changes
0	-	All Chapters	Initial Issue
1	-	All Chapters	General revision during initial preparation
2	2/91	All Chapters	General revision to incorporate early DOE-SR Review Comments
3	8/92	All Chapters	Editorial Update
4	12/92	Chapter 4	Incorporate DOE Order 6430-1A
5	5/93	Chapter 12 Appendix C	Update QA Plan Delete Comments/Resolution Appendix
6	6/93	Chapter 4 Chapter 13	Add Safety Class Items Section Revise Emergency Plan
7	7/93	Chapter 6 Chapter 7	Update process description Update waste management section
8	8/93	Chapter 1 Chapter 3 Chapter 4 Chapter 5 Chapter 8 Chapter 10 Chapter 14 Appendix A Appendix B P&IDs Vols. A & B	Update facility description Utilize SRS Site Generic SAR References Update Principle Design Criteria Update facility design description Update Safety Programs description Update Conduct of Operations description Revise glossary of terms Delete Basic Data Report Delete Material Data Sheets Revise P&ID package
9	1/94	Chapter 9	Update accident analysis
10	1/94	Chapter 2 Chapter 11	Revise Accident summary Update Operational Safety Requirements
11	8/94	Chapter 1, Chapter 3 through 8, Chapter 10, 12, 13 and 14.	Update to incorporate DOE / TRG comments.
12	5/95	All Chapters	Complete revision to incorporate technical requirements of DOE Order 5480.23 (SARs)
13	11/95	Chapters 1 through 12; Chapter 13, Section 13.2, only.	Incorporation of DOE review comments and addition of new Chapter 11, Derivation of TSRs. Chapter 13 (except for Section 13.2) and Chapter 14 remain Revision 12.
14	11/95	Chapter 11	Incorporation of DOE review comments.

DWPF FSAR REVISION LOG

Rev.	Date	Chapters Affected	Description of Changes
15	6/96	Chapter 11	Updated for coupled sludge/precipitate operation and to reflect TSRs Rev. 7.
16	3/97	All Chapters except Chapter 3	Annual FSAR revision
17	4/98	All Chapters	Annual FSAR revision
18	02/00	All Chapters except Chapter 3	Annual FSAR revision
19	1/01	All Chapters	Annual FSAR revision
20	1/02	All Chapters except 2, 3, 4, and 6.	Annual FSAR revision
21	7/03	All Chapters	Annual FSAR revision
22	7/04	All Chapters except 3 and 6.	Annual FSAR revision
23	9/05	All Chapters except Chapter 12.	Annual FSAR revision
24	7/06	All Chapters except Chapters 8 and 12.	Annual FSAR revision
25	10/06	All Chapters except Chapters 3, 10, 12 and 13	Updated for the Modular CSSX Unit and the 241-96H Facilities operation with DWPF.
26	7/07	All Chapters except Chapters 3, 12 and 13	Annual FSAR revision
27	7/08	All Chapters except Chapters 3, 12 and 13	Annual FSAR revision
28	7/09	All Chapters	Annual FSAR Revision incorporated DOE Interim Guidance
29	7/10	All Chapters except 7, 10, 12 and 13	Annual FSAR revision
30	7/11	All Chapters	Annual FSAR revision
31	7/12	All Chapters except 3, 12, and 13	Annual FSAR revision: Incorporated SBD-S-11-003 Rev. 0, SBD-S-11-004 Rev. 0, SBD-S-11-006 Rev. 0, SBD-S-12-002 Rev. 0, SBD-S-12-005 Rev. 0, and Comments from Comment Resolution Database.

DWPF FSAR REVISION LOG

32	7/13	All Chapters except 3, 10, 12, and 13	Annual FSAR revision: Incorporated SBD-S-11-005 Rev. 1, SBD-S-12-006 Rev. 1, SBD-S-13-001 Rev. 0, SBD-S-13-003 Rev. 1, SBD-S-13-004 Rev. 0, RCT/DWTT/RPT Purge modifications, and comments from Comment Resolution database
33	7/14	All Chapters except 2, 3, 10, 12, and 13	Annual FSAR revision: Incorporated SBD-S-13-005 Rev. 2, SBD-S-13-006 Rev. 2, and comments from Comment Resolution database
34	7/15	All Chapters except 12	Annual FSAR revision: Incorporated SBD-S-12-001 Rev. 3, SBD-S-14-002 Rev. 1, SBD-S-14-006 Rev. 1, SBD-S-14-007 Rev. 0, SBD-S-14-003 Rev. 0, SBD-S-14-003 Rev. 2, SBD-S-15-001 Rev. 0, and comments from Comment Resolution database.

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CHAPTER 1

INTRODUCTION AND GENERAL DESCRIPTION OF THE DEFENSE WASTE PROCESSING FACILITY

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1.0 INTRODUCTION AND GENERAL DESCRIPTION OF THE DEFENSE WASTE PROCESSING FACILITY

1.1 INTRODUCTION

1.1.1 SCOPE OF THIS REPORT

This Final Safety Analysis Report (FSAR) describes in detail the final design and final safety analysis of the Defense Waste Processing Facility (DWPF), which is that portion of the DWPF situated within the S-Area portion of the Department of Energy's Savannah River Site (SRS) near Aiken, South Carolina.

This FSAR addresses the changes to design criteria, design bases and facility design(s) from those described and documented in the DWPF Preliminary Safety Analysis Report (PSAR) (Ref. 1). It describes the present configuration of the plant, the processes as designed to vitrify radioactive sludge, and the safety analysis that supports the safety of the process. This FSAR demonstrates that the DWPF can and will operate in a manner that will not create an unacceptable risk to offsite individuals or jeopardize worker safety while processing radioactive materials as designed. It meets the technical requirements but not the format described in DOE-STD-3009, July 1994. The matrix included in Section 1.7 provides a guide to where the requirements of STD-3009 are satisfied in this FSAR.

The DWPF is classified as a Hazard Category 2 facility. The basis for this classification is discussed in Section 9.3.

1.1.2 DOE ORDER 6430.1A COMPLIANCE

At the time DOE Order 6430.1A was issued (April 1989), the DWPF design was more than 99% complete and construction was approximately 94% complete. Therefore, DOE Order 6430.1A was not a design basis document for the DWPF. Evaluations have been performed, however, to determine the extent to which the DWPF design addresses the DOE Order 6430.1A criteria (Ref. 2, 3, 4). The evaluations reviewed over 3000 design items and concluded that the DWPF design was consistent with the vast majority of the applicable DOE Order 6430.1A design criteria.

The DOE Order 6430.1A criteria related to Safety Class Items (SCI) (Section 1300.3.2) and the criteria related to structural design for natural phenomena hazards (Section 0111-99.0 and UCRL-15910) have been addressed in “Resolution of DWPF’s Safety Basis,” (Ref. 10) and are discussed in Sections 4.1, 4.2 and 4.3 of this FSAR.

Chapter 4 contains further analyses of the safety class and natural phenomena hazard criteria as applied to DWPF.

1.1.3 COMPLIANCE WITH OTHER DOE ORDERS

In addition to DOE Order 6430.1A, compliance with other DOE Orders at DWPF was assessed in accordance with Manual 8B (Ref. 6). Manual 8B describes the approach and activities for determining compliance with DOE Orders that apply to DWPF startup and operation. This manual establishes the scope, methodology, and management philosophy to be applied to the assessment of Order compliance for DWPF and provides assurance that SRS was prepared to startup DWPF in compliance with applicable DOE Orders listed in Table 1.0-1.

The DWPF 90-2 Program Plan implemented the DOE Office of Environmental Restoration and Waste Management (EM) program for DNFSB recommendation 90-2 at DWPF (Ref. 7). The current program for assessing DOE Orders, Codes, and Standards for applicability to DWPF is in accordance with Manual 8B.

1.1.4 FACILITY BACKGROUND AND SITING

This section summarizes the purpose of the DWPF facility and its structures. Its location within the Savannah River Site is described, as is the proximity of the DWPF to the general public and to other facilities. Population location and density related to assessment of the protection of the health and safety of the public are summarized.

Since startup of the F and H chemical separation areas in 1954, about 83 million gallons of aqueous radioactive wastes have been generated from reprocessing of irradiated reactor materials. Waste management campaigns have reduced this volume, primarily by evaporation and concentration. Over the next 24 years (Ref. 8), depending on a number of factors, the DWPF will solidify the current waste inventory of approximately 35 million gallons which is stored in waste tanks in the F-Area and H-Area waste tank farms. See Chapter 6 of this FSAR for more details.

The DWPF converts alkaline slurries of aqueous High Level Waste (HLW) into a durable borosilicate glass waste form (vitrification) suitable for eventual disposal in a geological repository.

The environmental consequences associated with the operation of the DWPF are given in the Final Environmental Impact Statement for the DWPF, issued in 1982 and the "Final Supplemental Environmental Impact Statement" (Ref. 8).

1.1.5 FACILITY OVERVIEW

1.1.5.1 <u>Geography</u>

The SRS occupies portions of Aiken, Allendale, and Barnwell Counties in southwestern South Carolina. The DWPF is in Aiken County, near the center of the SRS and about 6.5 miles southeast of the nearest site boundary. As shown in Figure 1.1-2, the SRS is centered approximately 25 miles southeast to the closest edge of the city limits of Augusta, Georgia, 100 miles from the Atlantic Coast, about 110 miles from the North Carolina border to the north-northwest. The SRS is bounded on the southwest by the Savannah River.

Prominent man-made geographical features within 50 miles of the DWPF include the Strom Thurmond Reservoir and Par Pond. The Strom Thurmond Reservoir of the U.S. Army Corps of Engineers, which is the largest nearby public recreational area, is on the Savannah River about 40 miles northwest of the DWPF site. Par Pond, which is a reactor cooling-water impoundment (about 2,640 acres) inside the SRS and closed to the public, lies about 5 miles east-southeast of DWPF.

The SRS has five production reactors, which are no longer operative, a heavy water plant that was shut down in early 1982, a fuel fabrication area, two separations plants for reprocessing irradiated fuel and recovery of isotopes, tank farms where high level wastes are treated and stored, process development laboratories to support production operations (Savannah River National Laboratory), and associated other support facilities.

The location of the DWPF site relative to Z-Area and H Area is shown in Figure 1.1-1. The 200-H Area is one of two separations plants at SRS that process irradiated materials and concentrate and store liquid high level radioactive waste. The Z-Area (Saltstone) facility immobilizes low level radioactive liquid waste received from H-Area in a grout mixture. The grout is stored in onsite vaults.

The DWPF boundary is roughly rectangular, measuring about 0.3 miles by 0.4 miles. The site is designated as 200-S-Area, and is enclosed by a property-protection fence.

1.1.5.2 Demography

The 1990 population (U.S. Census) within 50 miles of the center of SRS was approximately 730,000, with about 1,500 persons residing within 10 miles of the center of the SRS, and none residing within 5 miles. Augusta (pop. 45,000 in 1990) is the only city within this area with a population exceeding 25,000. The City of Augusta is the central city of a Standard Metropolitan Statistical Area (SMSA) with a 1990 population in excess of 350,000.

1.2 DEFENSE WASTE PROCESSING FACILITY DESCRIPTION

The layout of the DWPF, showing major permanent buildings and structures, is shown on Figure 1.2-1. The principal buildings and systems associated with the vitrification process include:

- Interarea transfer system, including the 512-S and Low Point Pump Pit (LPPP)
- Vitrification Building
- Glass Waste Storage Buildings
- Ventilation system, including Sand Filter, Fan House and Stack

These, and major support systems and facilities, are discussed below. A description of safety-related structures, systems and components is provided in Chapter 4.

1.2.1 INTERAREA TRANSFER SYSTEM

The Interarea Transfer System is an underground pipeline system used to transfer:

- High Level Waste (HLW) sludge slurry from H-Area to the DWPF
- MST/Salt Solution from H-Area to 512-S
- MST/Sludge Solids from 512-S to the DWPF
- Filtrate from the 512-S to Modular Caustic Side Solvent Extraction Unit (MCU),
- Strip Effluent (SE) from MCU to DWPF,
- Decontaminated Salt Solution (DSS) from MCU to Tank 50, and
- Recycle aqueous waste from the DWPF to H-Area

The Interarea Transfer System is shown in Figure 1.2-2. A cathodic protection system is provided for the pipeline to protect the outer metal covering of the interarea transfer system from electrochemical corrosion. The DWPF cathodic protection system will interface with the Salt Waste Processing Facility (SWPF) cathodic protection system as discussed below.

DWPF has several interfaces with CSTF. The following describes the DWPF boundaries with CSTF:

- The DWPF-CSTF boundary for the sludge transfer line from Tanks 40 to the LPPP is at the seal plate of the Tank 40 valve box.
- The DWPF-CSTF boundary for the ARP feed (MST/Salt Solution) transfer line from H-Area to 512-S is at the seal plate of the Tank 49 valve box.
- The DWPF-CSTF boundary for the ARP Filtrate transfer line from 512-S to MCU is at the seal plate located at the wall of the MCU Facility.
- The DWPF-CSTF boundary for the MCU SE transfer line from MCU to DWPF is at the seal plate located at the wall of the MCU Facility.

- The DWPF-CSTF boundary has two points for the DSS transfer line from MCU to Tank 50. One is at the seal plate located at the wall of the MCU Facility and the other is at the seal plate located at the highest transfer elevation point between 512-S and Tank 50.
- The DWPF-CSTF boundary for the DWPF recycle transfer line from LPPP to the H-Area Diversion Box is at the penetration to HDB-8.

The 512-S, used for actinide removal of salt solutions, and the LPPP serve as intermediate processing/transfer facilities. The 512-S filters the sludge and MST, if utilized, (laden with strontium and actinides) from the MST/Salt Solution, transferred by an interarea transfer line from the H-Area Tank Farm, by use of a cross flow filter. The MST/Sludge Solids (containing the strontium and actinides) are concentrated in the Late Wash Precipitate Tank (LWPT) in the 512-S, then transferred through an interarea transfer line to the LPPP Precipitate Pump Tank (PPT). The contents of the PPT are then transferred to the Precipitate Reactor Feed Tank (PRFT) in the Vitrification Building where it can be mixed with sludge slurry in the Sludge Receipt Adjustment Tank (SRAT). Filtrate from the 512-S is collected in the Late Wash Hold Tank (LWHT) in the 512-S Building, and then transferred by an interarea transfer line to the H-Area Tank Farm (MCU). In the MCU Facility, the Filtrate is processed to remove the radioactive Cs-137 using organic solvent producing a DSS. The following organic solvents may be used with MCU processing: BOBCalix-based solvent (the original CSSX solvent), Next Generation Solvent (NGS), or a blend of the two. The DSS is transferred by an interarea transfer line from MCU to the H-Area Tank Farm. The Cs-137 enriched SE produced in MCU is transferred by an interarea transfer line from the MCU via the LPPP Sludge Pump Tank (SPT) cell to the Strip Effluent Feed Tank (SEFT) in the Vitrification Building where it can also be mixed with the combined sludge slurry/MST/Sludge Solids in the SRAT. Sludge slurry from the H-Area Tank Farm is transferred by interarea transfer lines to the LPPP Sludge Pump Tank (SPT). The SPT is pumped to the SRAT in the Vitrification Building by another interarea transfer line.

DWPF has the following interface with SWPF:

- There will be a period of time, during SWPF construction, when DWPF and SWPF transfer pipes will be near each other but not physically connected. During this period, the cathodic protection systems will be connected via a bonding wire. The DWPF-SWPF boundary for the cathodic protection system protecting the SWPF West Waste Transfer Line and the transfer line from the LPPP to 221-S is the interface of the bonding wire and the SWPF Potential Test Station PTS01.

1.2.2 VITRIFICATION BUILDING

Vitrification Building 221-S houses the process equipment used to vitrify the high level radioactive waste. Most of these process operations are performed in concrete shielded, remotely operated cells, which include:

- Salt Process Cell (SPC) – the cell adjacent to the Chemical Process Cell through which material is transferred from the LPPP-PPT to the CPC.

- Chemical Process Cell (CPC) – the cell where the melter feed is prepared and the process vessel vents, melter off-gas, and aqueous recycle streams are treated.
- Melt Cell (MC) – the part of the process cell which houses the glass melter.
- Canister Decontamination Cell (CDC) – the cell which houses the equipment required to decontaminate the external surfaces of the canister.
- Weld and Test Cell (WTC) – A separate cell with its own air supply which houses the welding equipment used to make the final canister closure.
- Remote Equipment Decontamination Cell (REDC) and Contact Decontamination and Maintenance Cell (CDMC) – These are facilities for the cleaning, routine maintenance, repair, modification, testing, and inspection of contaminated process equipment from DWPF and from other facilities.

Figures 1.2-4 through 1.2-14 provide plan and cross-section views of the Vitrification Building and locations of some of the equipment.

1.2.3 GLASS WASTE STORAGE BUILDINGS (GWSB #1 & GWSB #2)

Glass Waste Storage Buildings 250-S and 251-S serve as the storage locations for filled canisters. The GWSBs have four areas inside: a storage vault, an operating area above the vault, air inlet shafts, and air exhaust shafts.

The canister storage vault in each building is below the operating floor and is constructed to be seismic and tornado resistant. Decay heat from the filled canisters is removed either by the natural circulation of air or by forced draft ventilation. The exhausted air is sampled periodically for radioactive contamination. Figures 1.2-15 & 1.2-15a show a section of the facility.

1.2.4 VENTILATION SYSTEMS

Two types of ventilation systems are used in the DWPF: one type for ventilating areas that are potentially contaminated (chemically or radiologically), and another type for ventilating clean, contamination-free areas.

Ventilation systems for clean areas provide only ventilation and comfort conditioning, with some removal of heat loads. Such systems are provided for the Operations Building, Service Building, and various support buildings and enclosures. Ventilation systems for contaminated or radiological areas are designed to prevent the spread of airborne contamination through the openings in confinement barriers, as well as to provide ventilation, comfort conditioning, and removal of heat loads. The spread of contamination is controlled by filtration and by regulating the direction of air flow away from building zones of low contamination potential. This type of ventilation system services the Vitrification Building, the radiological change rooms in the Service Building, and the pump pits. The ventilation systems for the Glass Waste Storage Building Vaults are designed for removal of the canisters decay heat.

1.2.4.1 Ventilation Control

The process areas of the Vitrification Building are divided into three zones for purposes of ventilation and contamination control. Zone 1 contains the areas with the highest potential for contamination and Zone 3 the areas with the lowest potential for contamination. Therefore, the air pressure is maintained lowest (most negative) for Zone 1 and highest (least negative) for Zone 3. Figures 1.2-16 and 1.2-17 show ventilation zone relationships and flow paths.

The areas included in each ventilation zone are as follows:

- Zone 1 includes the Chemical Process Cell (CPC), the Salt Process Cell (SPC), the Crane Maintenance Area (CMA), the Canister Decontamination Cell (CDC), the Melt Cell (MC), the Remote Equipment Decontamination Cell (REDC), the Remote Process Cell Plenum (RPCP), the Contact Decontamination and Maintenance Cell (CDMC), the analytical cell, and the sample and mercury purification cells. The Weld and Test Cell (WTC) is also characterized as Zone 1, but it is designed to be maintained at slightly positive pressure relative to the remainder of Zone 1.
- Zone 2 includes all normally occupied areas with potential for contamination such as service corridors on levels 1 and 3, all radiological shops and the Manipulator Repair Shop (MRS). The Shielded Canister Transporter (SCT) decontamination and maintenance area is not considered part of Zone 2, but exhausts into Zone 2. A portion of Building 210-S is used for processing radiological control samples, and exhausts air to the Zone 2 system. The 210-S instrument decontamination lab, and the HP water sample analysis lab exhaust through hoods into the Zone 2 system.
- Zone 3 includes all clean stairwells, clean offices, Field Operating Stations (FOSs) 1 and 2, clean machine shops, clean equipment area, personnel air locks, and other clean personnel areas on level 2. These areas are designed to maintain positive pressure relative to areas in Zones 1 and 2. However, Zone 3 pressure is designed to be slightly below atmospheric outdoor pressure.

With the exception of the WTC exhaust, the Zone 1 exhaust air is filtered by the Sand Filter. Except for the Zone 2 Railroad Well (RRW), which exhausts into Zone 1, Zone 2 exhaust air passes through roughing filters, then single-stage High Efficiency Particulate Air (HEPA) filters. Zone 3 exhaust air is cascaded through air supply units and is used as Zone 2 supply air. Refer to Section 5.4 for additional details.

1.2.4.2 Process Vessel Ventilation System

The Process Vessel Ventilation (PVV) system and the building ventilation system are designed to control the release of airborne hazardous materials to the environment from sources within the Vitrification Building. These systems also control the spread of radioactive contamination within the building, and the PVV in particular is designed to prevent the accumulation of hazardous and/or explosive vapors that might otherwise leak from process vessels into the surrounding air inside the Vitrification Building. Section 6.1 provides additional details.

Emissions of hazardous chemicals such as formic acid and mercury are maintained within limits specified by environmental regulations. Emissions of formic acid concentrations are not controlled independently, but are regulated as part of the total allowable Volatile Organic Compound (VOC).

1.2.4.3 Sand Filter

The Sand Filter (Building 294-S) is located west of the Vitrification Building. Space is reserved for future expansion west of the Sand Filter if required. The Sand Filter and tunnels are Category I structures and have been qualified as maximum resistance facilities to include loading conditions encountered during design basis tornadoes or earthquakes. Two underground inlet air tunnels from the Vitrification Buildings merge into one underground tunnel that connects to the Sand Filter. One exhaust air tunnel, partially above ground, connects the Sand Filter to the Fan House, and one above-grade duct connects the Fan House to the exhaust stack.

Ventilation air from the Vitrification Building process cells (Zone 1) is directed through the Sand Filter by Zone 1 exhaust fans in the Fan House. The contaminated air is fed underneath the filter bed through distribution troughs spaced along the length of the building, passes up through the graded filter bed to an open space at the top, and exits through the exhaust tunnel leading to the Fan House.

1.2.4.4 Fan House

The Fan House (Building 292-S) is a reinforced concrete structure designed as a maximum resistance facility to include loading conditions encountered during natural phenomena such as tornadoes or earthquakes. This structure houses diesel generators, exhaust fans, electrical equipment, and diesel fuel day tanks. Inlet and exhaust tunnels, located under the fan room, connect to a tunnel from the Sand Filter, and through the exhaust fans to an above-grade duct into the exhaust stack. A sampling station for measuring chemical and radioactivity emissions is located in the Fan House.

Diesel generators are located in the Fan House to provide power to safety significant loads when normal power is not available. There is a fuel oil storage and transfer system.

1.2.4.5 Exhaust Stacks

The Zone 1 exhaust stack is a standard construction steel structure that is located southwest of the Fan House. The stack is supported by a concrete foundation. The height of the stack provides elevated release during normal operations and post-accident conditions. Refer to Section 5.4 for details of the equipment and sample station. The Zone 2 exhaust stack is located on the roof of the Vitrification Building and is supported by a concrete foundation. The 512-S exhausts through a stack located at the south end of the 512-S building and the Low Point Pump Pit exhausts through a stack located at the south end the LPPP.

1.2.4.6 Glass Waste Storage Building Ventilation

The Glass Waste Storage Buildings (250-S & 251-S) ventilation is described in Section 5.4.

1.2.5 DELETED

1.2.6 SUPPORT SYSTEMS AND FACILITIES

The systems discussed below provide support to the vitrification process.

1.2.6.1 Cold Chemical Feed System

The cold chemical feed system provides the necessary chemicals for process requirements and decontamination operations. Nitric and formic acid are supplied as process chemicals in the Sludge Receipt & Adjustment Tank and the Slurry Mix Evaporator. Nitric acid, potassium permanganate, caustic, and decontamination solutions are supplied individually for decontamination operations and neutralization. Nitric acid may also be supplied to the Melter Feed Tank for Melter feed adjustments. Cold chemical feed storage is located in Building 422-S, and surrounding areas. From there, cold chemicals may be transferred to feed tanks in the Vitrification Building. Spills, overflows, and equipment drains in the Vitrification Building are collected in separate floor drain, acid drain, and organic acid drain catch tanks. These are described further in Section 6.1.

1.2.6.2 Glass Frit Storage

The glass frit facilities receive, store, and prepare glass frit and glass frit slurry for use in glass making and canister decontamination processes. Components of the glass frit facilities are located in Buildings 422-S and 221-S.

1.2.6.3 Purge Systems

NITROGEN

The 422-S bulk nitrogen tank and ambient vaporizers provide nitrogen to the LPPP Primary Purge System. If this system fails, the LPPP Safety Grade Purge System will maintain the purge. The 422-S bulk nitrogen tank also provides nitrogen to the CPC Primary Purge System. The CPC Safety Grade Nitrogen Purge System provides nitrogen should the Primary Purge system fails. The 422-S bulk nitrogen tank and ambient vaporizers are also a source for other miscellaneous users.

The 512-S Nitrogen System provides nitrogen to purge the vessel vapor spaces of 512-S vessels.

AIR

Two air compressors are located in 422-S to provide an air purge to the CPC Primary Purge System.

1.2.6.4 Cooling/Chilled Water

The following cooling/chilled water systems are used in the DWPF. (These systems are further described in Section 5.4.)

- The melter closed cooling water system provides cooling to the melter to reduce the temperature of the outside surface of the melter. It includes two redundant systems composed of heat exchangers, circulating pumps and cooling water piping. Heat is transferred by the heat exchangers to the Cooling Tower water system. Water from the melter to the heat exchanger is monitored for radioactive contamination.
- The process closed cooling water system provides cooling water to various tanks and other equipment containing radioactive process solutions. This cooling water is used for removal of radioactive decay heat, cooling thermally heated solutions, and controlling temperatures of various process solutions. A closed loop cooling water system is used to ensure confinement of radioactive contamination in the event of a leak into the cooling water from the process equipment being cooled. Heat is transferred by the heat exchangers to the Cooling Tower water system.
- The process closed chilled water system provides chilled water to the following major equipment: the cooling coils in the slurry mix evaporator condensate tank (SMECT), the off-gas condensate tanks and off-gas condensers in the melter off-gas system, the formic acid vent condenser, and the Gas Chromatograph (GC) sample coolers. A closed loop chilled water system is used to ensure confinement of radioactive contamination in the event of a leak into the chilled cooling water from the process equipment being cooled with chilled water.
- The Cooling Tower system provides cooling water for the process equipment, air compressors, Heating, Ventilation, and Air Conditioning (HVAC) chillers, and other nonprocess equipment. Refer to Section 5.4 for details of the cooling water systems.
- HVAC closed chilled water systems supply and distribute chilled water to air conditioning cooling coils for Buildings 221-S and 210-S. The primary HVAC chilled water systems are the central refrigeration chillers, the control room/computer room HVAC chillers, and the Analytical Facilities HVAC chillers.
- The 512-S Complex closed chilled water system provides cooling water to remove heat from operation of LWPT mechanical components and radioactive decay heat from waste that is processed.

1.2.6.5 Chemical and Industrial Waste Treatment

The chemical and industrial waste treatment system provides pH treatment of nonradioactive chemically contaminated waste water from chemical operations in cold feed and process areas. The system consists of piping used to carry acid, caustic, organic wastes and treated chemicals to the treatment station; chemical waste storage and treatment facilities; and disposal facilities for treated waste.

Caustic and acid waste from the cold chemical operations at the Vitrification Building, bulk frit and cold feed storage, and the primary water treatment building are neutralized. Organic acid wastes from the Vitrification Building and the cold feed storage area are collected and transferred to organic waste neutralization tanks. The neutralized wastes are discharged at a regulated rate into the Cooling Tower blowdown stream for disposal. Section 7.3 provides additional detail.

1.3 UTILITIES AND SERVICES

1.3.1 ELECTRICAL

Primary electrical power for the DWPF is supplied from the 200-H-Area substation, which is part of the Savannah River Site's power grid. The SRS grid is a network of substations and 115-kV transmission lines supplying power to the various SRS facilities. Two standby diesel generator sets, seismically qualified to function during and after a DBE, provide standby power to safety significant users.

The 125-VDC systems utilize batteries and battery chargers to supply DC loads at DWPF. These loads consist of switchgear and load center circuit breaker control power, diesel generator control power, annunciators, and instrumentation. Refer to Section 5.4 for additional details.

The DWPF facility utilizes Uninterruptible Power Supplies (UPS) for process support applications. Reliable power is assured through the use of batteries and input power source(s). Refer to Section 5.4.2 for additional details.

A network of lightning protection systems is used to minimize lightning strikes in key areas of DWPF.

1.3.2 COMPRESSED AIR

Compressed air services supplying plant, instrument, decontamination, and breathing air are provided to process and service area users.

Plant/Instrument Air – The building plant/instrument air requirements are met by three air compressors. Two compressors are normally operated and the third unit acts as a backup. Two 100% capacity air dryers and one air receiver are provided for the instrument air system. One air receiver is provided for the plant air system. Refer to Section 5.4 for additional details.

Breathing Air – Primary breathing air is provided by a compressor located on the first level of the Service Building in the mechanical room. A manifold of high pressure breathing air cylinders in the Vitrification Building provides emergency backup breathing air. Refer to Section 5.4 for additional details.

The LPPP instrument air is provided by the vitrification building compressors.

The 512-S Complex uses compressed dried air from H-Area for select compressed air users and nitrogen for the remaining compressed gas users.

1.3.3 STEAM SUPPLY AND DISTRIBUTION

DWPF steam is supplied by an interarea line from H-Area. Steam is supplied to the 512-S Complex, the Low Point Pump Pit, Building 980-S Water and Chemical Waste Treatment Facility, and Buildings 221-S and 210-S for building and process heating and the operation of auxiliary equipment.

Closed-loop process steam, consisting of a steam-heated steam generator and distribution piping, is delivered to selected vessels in the CPC. The closed loop system ensures isolation of radioactive contamination in case of a coil leak and depressurization.

Vessels in the CPC for which steam is provided, as well as other miscellaneous steam users, and additional details, are described in Section 5.4.4.

An electrically powered steam boiler can also be used to supply steam to the REDC to facilitate decontamination activities as required.

1.3.4 WATER SUPPLY

Domestic water is provided by a sitewide domestic water system. There is a connection in DWPF which provides domestic water to the Salt Waste Processing Facility.

Neutralized water is provided by wells located in DWPF. The water is neutralized to reduce piping corrosion. A combination electric and diesel-driven pump is provided for each well. The neutralized water system supplies non chlorinated makeup water to the Cooling Tower and to the process water system.

Water for the fire protection system is stored in the Neutralized Fire Water Storage Tank Facility, 980-S. Fire protection systems are described in Section 5.4.

1.3.5 SEWAGE TREATMENT

Sewage treatment at DWPF consists of a lift station, which is piped to the Central Sanitary Wastewater Treatment Facility. No sewage treatment is done in DWPF.

1.3.6 STORM SEWERS

Storm sewers provide a total system for the collection and disposal of storm water runoff. The storm sewers consist of a gravity flow collection system of drains, pipes and catch basins, designed to remove excessive surface runoff. Refer to Section 7.3 for additional information.

1.3.7 COMMUNICATIONS AND ALARMS

The DWPF communications and alarm networks provide communications between various locations within DWPF, and provide interconnections with other SRS and offsite communication systems. These facilities are comprised of diverse subsystems that are employed for normal operating and maintenance communications, for warning personnel of potential hazardous conditions, for communication during emergencies, and for requesting outside assistance.

1.3.7.1 Communications Network

The communications network includes the following major systems:

- System telephone extension into DWPF – the existing SRS telephone network extends into DWPF and is integrated with the DWPF system.
- Dedicated Selective Signal Terminal (SST) telephones in the Central Control Room (CCR) to provide direct communications for fire notifications and to Security headquarters.
- Public address system speakers are strategically located throughout the area to ensure that vital information reaches all personnel. This system is normally used for operating, maintenance, and paging and can be accessed from the CCR or FOS-1.

1.3.7.2 Alarm Systems

The alarm systems include:

- Fire alarm system – The DWPF fire alarm system is independent, but reports to the SRS Operations Center (SRSOC) through the SRS telephone wire system. The system is coded to identify the DWPF alarm locations for quick response by SRS firefighters.
- Plant operational alarms system – This system includes radiation alarms for high airborne radioactivity concentrations in building air, alarms for high radioactive material concentrations in plant liquid systems, and operational alarms for equipment.

1.4 PROCESS DESCRIPTION

1.4.1 WASTE STREAM CHARACTERISTICS

Radioactive waste to be processed by 221-S is received as:

- Insoluble solids (sludge), which separate from the waste after it is received in the HLW waste tanks
- MST/Sludge Solids from salt solutions resulting from the Actinide Removal Process (ARP)
- Strip Effluent (SE) is an aqueous cesium enriched waste resulting from the MCU processing

Sludge comprises about 10 vol% of the stored waste and is a complex mixture of precipitated metal hydroxides, mostly iron, aluminum, manganese and nickel. Most of the radioactive contaminants in the waste are contained in the sludge.

Salt solutions processed in 96-H and/or 512-S to produce a MST/Sludge Solids stream which is transferred to the Vitrification Building where it is mixed with a sludge slurry waste stream for processing by vitrification. Figure 1.4-1 shows the interface between the DWPF and other process areas.

The Filtrate resulting from the ARP processing is sent to MCU for Cs-137 removal prior to being sent to Tank 50. The SE is produced at MCU, which contains the Cs-137 removed by the MCU process. This stream is then sent to DWPF where it is also mixed with a sludge slurry waste stream for processing by vitrification. The interface between MCU and DWPF is shown in Figure 1.4-1.

1.4.2 CHEMICAL PROCESSING

Feed material to 221-S includes sludge slurry from H-Area, MST/Sludge Solids produced by the Actinide Removal Process (ARP) in 512-S, and SE produced by the Cs-137 stripping process in MCU. Radioactive sludge is transferred from waste tanks in H-Area to the LPPP sludge tank as required to support DWPF operation. The LPPP sludge tank transfers sludge to the Sludge Receipt and Adjustment Tank (SRAT) in the CPC. MST/Sludge Solids and/or SE may be added. In H-Area, Salt Solutions can be treated with MST, to adsorb actinides and Sr-90 facilitating the concentration of MST/Sludge Solids by filtration in 512-S. The use of MST is determined by CST. The concentrated MST/Sludge Solids stream is transferred to the PRFT in the Vitrification Building via the LPPP-PPT. The Filtrate is transferred to MCU in H-Area where the Cs-137 is stripped producing an SE stream that is sent to DWPF for vitrification via the LPPP-SPT Cell. The resultant MCU DSS stream is sent to Tank 50 for disposal at the Saltstone Facility.

The MST/Sludge Solids stream is transferred from the PRFT to the SRAT and mixed with the sludge feed. The SE is sent from the SEFT to the SRAT and mixed with material in the SRAT (Figure 1.4-2).

The sludge slurry in the SRAT is analyzed once the sludge is transferred from the pump pits. MST/Sludge Solids and/or SE may be added. Nitric acid and formic acid are added to the SRAT. Formic acid is used to reduce mercury compounds in the sludge to mercury. In the SRAT, the elemental mercury is steam distilled to a decanting/wash tank. Mercury is periodically removed from the wash tank and transferred to the mercury recovery and purification facilities in the laboratory area. Frit is added to the sludge mixture in the Slurry Mix Evaporator tank (SME) to form a sludge-frit slurry. Acid is added, as required, to control redox or rheological properties of the slurry. The solid-liquid ratio of the slurry is adjusted by evaporation, and the slurry mixture is then transferred to the Melter Feed Tank and fed into the melter at a controlled rate. In the Melter Feed Tank, nitric acid may be added for Melter feed adjustments.

1.4.2.1 Mercury Separation

Elemental mercury generated in the Chemical Process Cell (CPC) during the sludge adjustment process collects in the Mercury Water Wash Tank (MWWT). Small amounts of mercury may also collect in the slurry mix evaporator condensate tank and subsequently be washed in the MWWT. Each of these process vessels has an opening to allow installation of a pump to transfer mercury from the sump to the SMECT, then to the Mercury Water Wash Tank (MWWT) in the Chemical Process Cell (CPC). The washed mercury is transferred to the mercury purification cell where it is scrubbed with nitric acid and process water and optionally vacuum distilled.

1.4.3 VITRIFICATION

The melting process is accomplished in a slurry-fed, joule-heated melter. The melt process incorporates high level radioactive waste into a solid, borosilicate glass matrix. The melter is fed an aqueous slurry of waste and glass-forming material (frit). The melter performs the principal vitrification process operations of drying, calcining, and melting in a single process vessel.

After initial startup, slurry is fed onto the crust (cold cap), which covers most of the melt surface and is composed of calcined waste and frit. The cold cap, in contact with the molten glass below, melts from the bottom and becomes a part of the molten borosilicate glass-waste matrix. The molten glass is poured into stainless steel canisters. The process is described in detail in Section 6.1.

Figure 1.4-3 is a block flow diagram for the DWPF process.

1.4.4 STORAGE OF CANISTERS

The Shielded Canister Transporter (SCT) transfers filled and decontaminated glass waste canisters to the Glass Waste Storage Buildings (GWSBs) (Buildings 250-S & 251-S) for storage. The SCT design minimizes operator exposure.

The storage vault portion of the GWSBs are designed to hold the glass waste canisters in a manner that ensures protection to operating personnel, the public, and the environment. Section 4.4.56 provides the details of the storage vaults.

Radiation shielding protection for personnel is provided by concrete walls, earth embedment, and a concrete deck which forms the floor of the operating area.

1.4.5 WASTE MANAGEMENT

A waste management program is in effect to manage both radioactive and hazardous process wastes and is detailed in Chapter 7. The processes are summarized below.

1.4.5.1 Aqueous Wastes

The DWPF aqueous radioactive waste streams are collected in the Recycle Collection Tank in the CPC and then returned through the LPPP and the interarea transfer lines to the Tank Farms. There the supernate is evaporated and processed in a manner identical to that for existing supernate waste. Interface controls governing the chemical content of these wastes are listed in Section 7.1.

Nonradioactive aqueous wastes from the cold chemical tank drains and vents are collected in separate drain tanks and transferred to neutralization tanks in the Water & Chemical Waste Treatment building. There the contents are normally diluted with other aqueous wastes, neutralized, sampled, and discharged per Chapter 7, Section 7.3.2.

1.4.5.2 Gaseous Wastes

Radioactive gaseous wastes originate from the process vessels. These are diluted with process ventilation air, routed through a sand filter or HEPA filters and exhausted through stacks for elevated release. Non radioactive gaseous wastes are treated as described in Section 7.3. All releases are controlled within SCDHEC permit limits.

1.4.5.3 Solid Wastes

Radioactive solid wastes are classified in accordance with Manual 1S, SRS Waste Acceptance Criteria Manual, and disposed of according to SRS requirements. The program is discussed in Section 7.7.4.

1.5 SAFETY MANAGEMENT PROGRAMS

1.5.1 FACILITY SAFETY PROGRAMS

The Facility Safety Programs include the following programs:

- Radiological Protection Program, summarized in Section 8.1
- Industrial Hygiene Program, summarized in Section 8.2
- Industrial Safety Program, summarized in Section 8.3
- Fire Safety Program, summarized in Section 8.4
- Criticality Safety Program, summarized in Section 8.5

All of the above facility safety programs are Site-wide generic programs and are implemented at DWPF . These safety programs and their controls, as well as the dedicated organizations which support them, are summarized and referenced in Chapter 8 of this FSAR.

1.5.2 EMERGENCY PREPAREDNESS

The Emergency Preparedness Program is a Site-wide generic program that has specific application to each facility, based on the hazards analysis. Chapter 13 summarizes the DWPF Emergency Preparedness Program, its controls and specific application to DWPF.

1.5.3 QUALITY ASSURANCE

The Quality Assurance Program is a Site-wide generic program with specific application to DWPF. This program is summarized in Chapter 12.

1.6 ORGANIZATIONS

1.6.1 DESIGN AND CONSTRUCTION

The Engineering Department of E.I. du Pont de Nemours and Company contracted with the Bechtel Corporation as engineering contractor for the design of the DWPF at the SRS. Du Pont's Engineering Department, which had total project responsibility, established basic requirements and Bechtel translated these requirements into designs suitable for use in procurement and construction to meet the performance criteria. Bechtel also assisted in project engineering and provided liaison assistance to Du Pont's Design Division during construction. Du Pont monitored and approved all significant phases of the work. Bechtel's Quality Assurance Program was approved by Du Pont.

In 1989, the Westinghouse Savannah River Company (WSRC) replaced Du Pont as the prime contractor for SRS. The Westinghouse Savannah River Company subsequently changed its name to Washington Savannah River Company (WSRC). The construction function of the DWPF was the responsibility of Bechtel Savannah River Company Incorporated (BSRI). As prime contractor, WSRC Engineering and Construction Services was the design agency and Waste Disposition Engineering was the design authority.

1.6.2 DWPF AND SRS SITE ORGANIZATION

The DWPF operation is the responsibility of the Liquid Waste (LW) contractor. The DWPF Project is under the management of the DWPF senior manager. The organization, its relationship to the LW organization and its responsibilities are summarized in Section 10.1.

1.6.3 CONSULTANTS AND CONTRACTORS

E.I. du Pont de Nemours and Company, and Westinghouse Savannah River Company contracted with several organizations in addition to Bechtel, to perform the detailed design of the DWPF, to conduct surveys, to perform analyses, and to prepare sections of the Safety Analysis Report. These are summarized in the following sections.

1.6.3.1 D'Appolonia Consulting Engineers, Incorporated

The Du Pont Engineering Department contracted with D'Appolonia Consulting Engineers, Inc. (DCE) to prepare the site characteristics part of the Preliminary Safety Analysis Report. This included gathering all field data, laboratory testing, and engineering analysis related to the geophysical aspects of the site. DCE provided a Quality Assurance Program approved by Du Pont to ensure that all QA requirements were adequately met.

1.6.3.2 Science Applications International Corporation (SAIC)

Du Pont contracted with SAIC to prepare an analysis of the potential process accidents associated with the operation of DWPF. The analysis determined source terms, frequency, and risk of potential accidents.

1.6.3.3 Pacific Northwest Laboratory (PNL)

Savannah River National Laboratory (formerly Savannah River Laboratory, Savannah River Technology Center) contracted with PNL to perform calcination and glass melting tests using simulated sludge.

1.6.3.4 Exploration Resources

Savannah River National Laboratory (SRNL) contracted with Exploration Resources to provide text and figures for sections of Chapter 3 of this FSAR.

1.6.3.5 URS Professional Solutions (URS PS)

URS PS provides safety analysis services, Unreviewed Safety Question (USQ) reviews and other related activities as directed by the LW contractor.

1.7 SAR ORGANIZATION

The initial edition of this SAR was prepared prior to the publication of DOE-STD-3009, and the FSAR chapters and sections do not follow the same sequence outlined in DOE-STD-3009. However, this FSAR meets all technical content requirements outlined in DOE-STD-3009. The following cross-reference matrix correlates STD-3009 topics with applicable sections in this FSAR.

DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
Executive Summary	Overview	Executive Summary
E.1	Facility Background & Mission	1.1.4
E.2	Facility Overview	1.1, 1.2, 1.3, 1.4, 2.2
E.3	Facility Hazard Categorization	1.0, 2.1, 9.3.2
E.4	Safety Analysis Overview	2.2
E.5	Organizations	1.6
E.6	Safety Analysis Conclusions	2.3
E.7	DSA Organization (Matrix guide)	1.7
Chapter 1	**Site Characteristics**	
1.1	Introduction	3.1
1.2	Requirements	3.2
1.3.1	Geography	3.3.1
1.3.2	Demography	3.3.2
1.4.1	Meteorology	3.4.1
1.4.2	Hydrology	3.4.2
1.4.3	Geology	3.4.3
1.5	Natural Event Accident Initiators	3.5
1.6	Man-Made External Accident Initiators	3.6
1.7	Nearby Facilities	3.7
1.8	Validity of Existing Environmental Analyses	3.8
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2.1	Introduction	5.0, 6.0
2.2	Requirements	5.2, 5.4.10, 6.1-6.5
2.3	Facility Overview	1.1, 6.0
2.5	Process Description	Chap 6
2.6	Confinement Systems	5.1.3, 5.2, 5.3
2.7	Safety Support Systems	5.4
2.8	Utility Distribution Systems	5.4
2.9	Auxiliary Systems and Support Facilities	5.3, 5.4

DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
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3.2	Requirements	9.2
3.3	Hazard Analysis	9.3
3.3.1	Methodology	9.3.1
3.3.1.1	Hazard Identification	9.3.1
3.3.1.2	Hazard Evaluation	9.3.1
3.3.2	Hazard Analysis Results	9.3.2
3.3.2.1	Hazard Identification	9.3.2
3.3.2.2	Hazard Categorization	9.3.2
3.3.2.3	Hazard Evaluation	9.3.2
3.4	Accident Analysis	9.4
3.4.1	Methodology	9.4.1
3.4.2	Design Basis Accidents	9.4.2
3.4.2.X	[Applicable Accident]	9.4.2.X
3.4.3	Beyond Design Basis Accidents	9.4.3
Chapter 4	**Safety SSCs**	
4.1	Introduction	4.1
4.2	Requirements	4.2
4.3.	Safety-Class SSCs	4.3
4.3.X	Applicable Safety Class SSCs	4.3.X
4.3.X.1	Safety Function	4.3.X.1
4.3.X.2	System Description	4.4.X.2
4.3.X.3	Functional Requirements	Table 4.3-1
4.3.X.4	System Evaluation	4.3.X.3
4.3.X.5	Controls (TSRs)	Chapter 11
4.4	Safety Significant SSCs	4.4
4.4.X	Applicable Safety Significant SSCs	4.4.X
4.4.X.1	Safety Function	4.4.X.1
4.4.X.2	System Description	4.4.X.2
4.4.X.3	Functional Requirements	Table 4.4-1
4.4.X.4	System Evaluation	4.4.X.3
4.4.X.5	Controls (TSRs)	Chapter 11

DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
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4.5.X	Applicable Specific Administrative Control	11.5.11.2.X
4.5.X.1	Safety Function	11.5.11.2.X.1
4.5.X.2	SAC Description	11.5.11.2.X.2
4.5.X.3	Functional Requirements	11.5.11.2.X.3
4.5.X.4	SAC Evaluation	11.5.11.2.X.4
4.5.X.5	Controls (TSRs)	TSRs 5.8.2.X
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5.3	TSR Coverage	11.3
5.4	Derivation of Facility Modes	11.4
5.5	TSR Derivation	11.5
5.5.X	Applicable Hazard/Feature /TSR “X”	11.5
5.5.X.1	Safety Limits, Limiting Control Settings, LCOs	11.5
5.5.X.2	Surveillance Requirements	11.5
5.5.X.3	Administrative Controls	11.5
5.6	Design Features	TSR 6.0
5.7	Interface with TSRs from Other Facilities	11.7
Chapter 6	**Prevention of Inadvertent Criticality**	
6.1	Introduction	8.5
6.2	Requirements	8.5
6.3	Criticality Concerns	8.5
6.4	Criticality Controls	8.5
6.5.1	Criticality Safety Organization	8.5
6.5.2	Criticality Safety Plans & Procedures	Not Applicable
6.5.3	Criticality Safety Training	8.5
6.5.4	Determination of Operational Nuclear Criticality Limits	Not Applicable
6.5.5	Criticality Safety Inspections/Audits	Not Applicable
6.5.6	Criticality Infraction Reporting	Not Applicable
6.6	Criticality Instrumentation	Not Applicable

DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
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7.4	ALARA Policy & Program	8.1.1
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7.6.1	Rad Administrative Limits	8.1.4
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8.4	ALARA Policy and Program	8.2.2.1
8.5	Hazardous Material Training	8.2.1, 8.2.2
8.6.1	Hazardous Material Identification Program	8.2.2, 8.2.3, 8.2.4, 8.2.5
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8.8	Hazardous Material Protection Instrumentation	8.2.5
8.9	Hazardous Material Protection Record Keeping	8.2.7
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DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
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10.3	Initial Testing Program	10.7
10.4	ISI Surveillance Program	10.8
10.5	Maintenance Program	5.4.11, 10.9
Chapter 11	**Occupational Safety**	
11.1	Introduction	10.3
11.2	Requirements	10.3
11.3	Conduct of Operations	10.3
11.4	Fire Protection	5.4.10, 8.4
Chapter 12	**Procedures and Training**	
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12.2	Requirements	10.5, 10.6
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Chapter 13	**Human Factors**	
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13.3	Human Factors Process	5.1.6.2
13.4	Identification of Human-Machine Interfaces	5.1.6.3
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14.2	Requirements	12.2
14.3	QA Program and Organization	12.3
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14.6.2	Design	12.4.2
14.6.3	Procurement	12.4.3
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DOE STD-3009 SECTION	TOPIC	DWPF FSAR SECTION
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15.4.2	Assessment Actions	13.5.2, 13.5.3
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17.4.1	Safety Review & Performance Assessment	10.2
17.4.2	Configuration & Document Control	10.4
17.4.3	Occurrence Reporting	10.2
17.4.4	Safety Culture	8.3

1.8 REFERENCES

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2. Defense Waste Processing Facility DOE Order Compliance Review (6430.1A). United Engineers and Contractors Report No. 8244.601-S-N-001, June 1989.

3. DOE Order 6430.1A Indeterminate Item Resolution. Summary Report WAP D5-934, Bechtel National Inc., Final Report, August 1991.

4. Defense Waste Processing Facility DOE Order 6430.1A Non-Compliant Item Resolution. Document No. M-DRR-S-001, Rev. 0.

5. Deleted.

6. Compliance Assurance Manual (U). Manual 8B.

7. Transmittal of DWPF 90-2 Program Plan (U). Rev. 6, OPS-DTL-93-0053, D.B. Amerine to C.W. Terrell.

8. Final Supplemental Environmental Impact Statement. DOE/EIS-0082-S2, June 2001.

9. Deleted.

10. Resolution of DWPF's Safety Basis (U). Technical Report WSRC-TR-94-0395, Rev. 2.

11. Deleted.

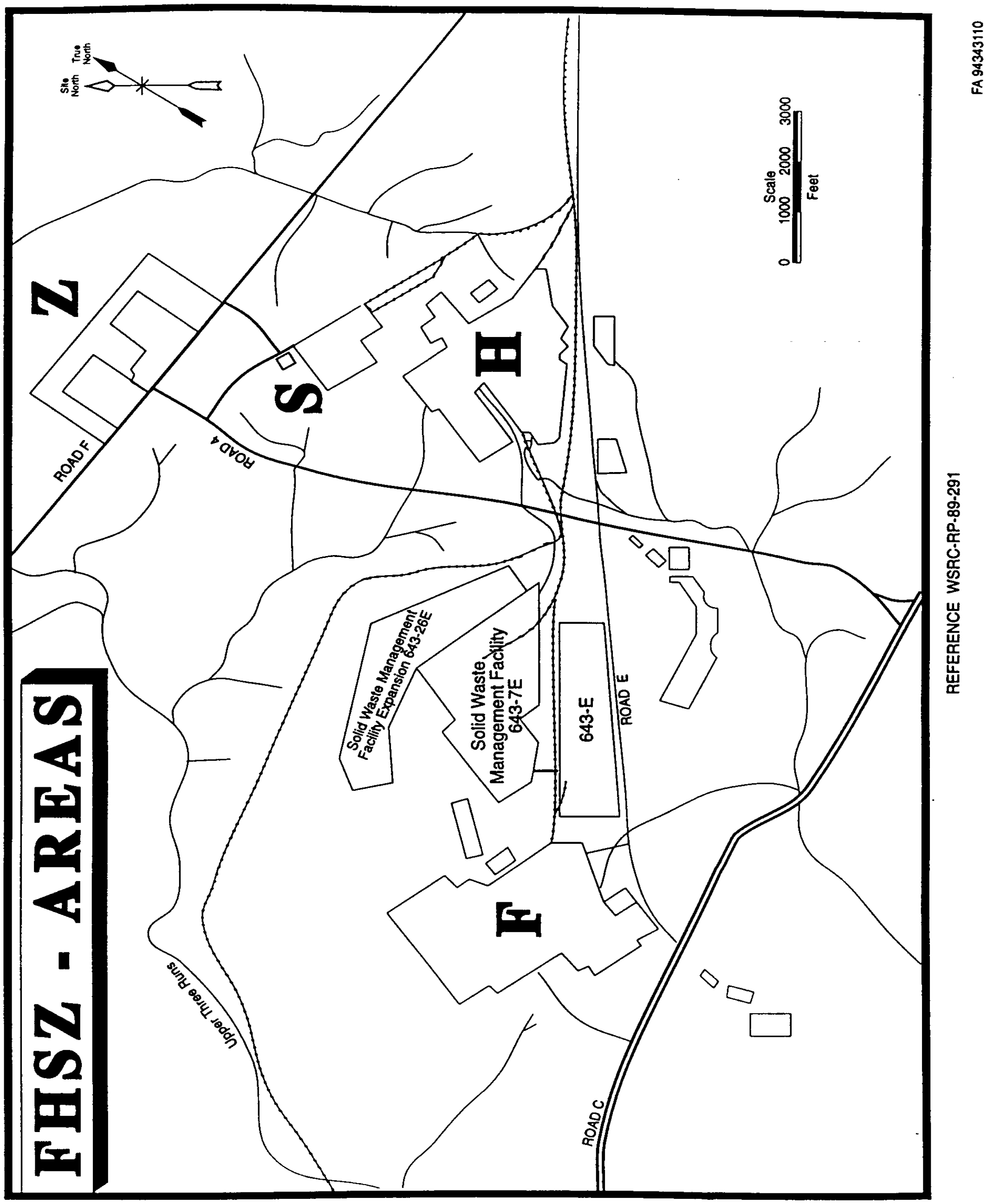


Figure 1.1-1 Separations and DWPF

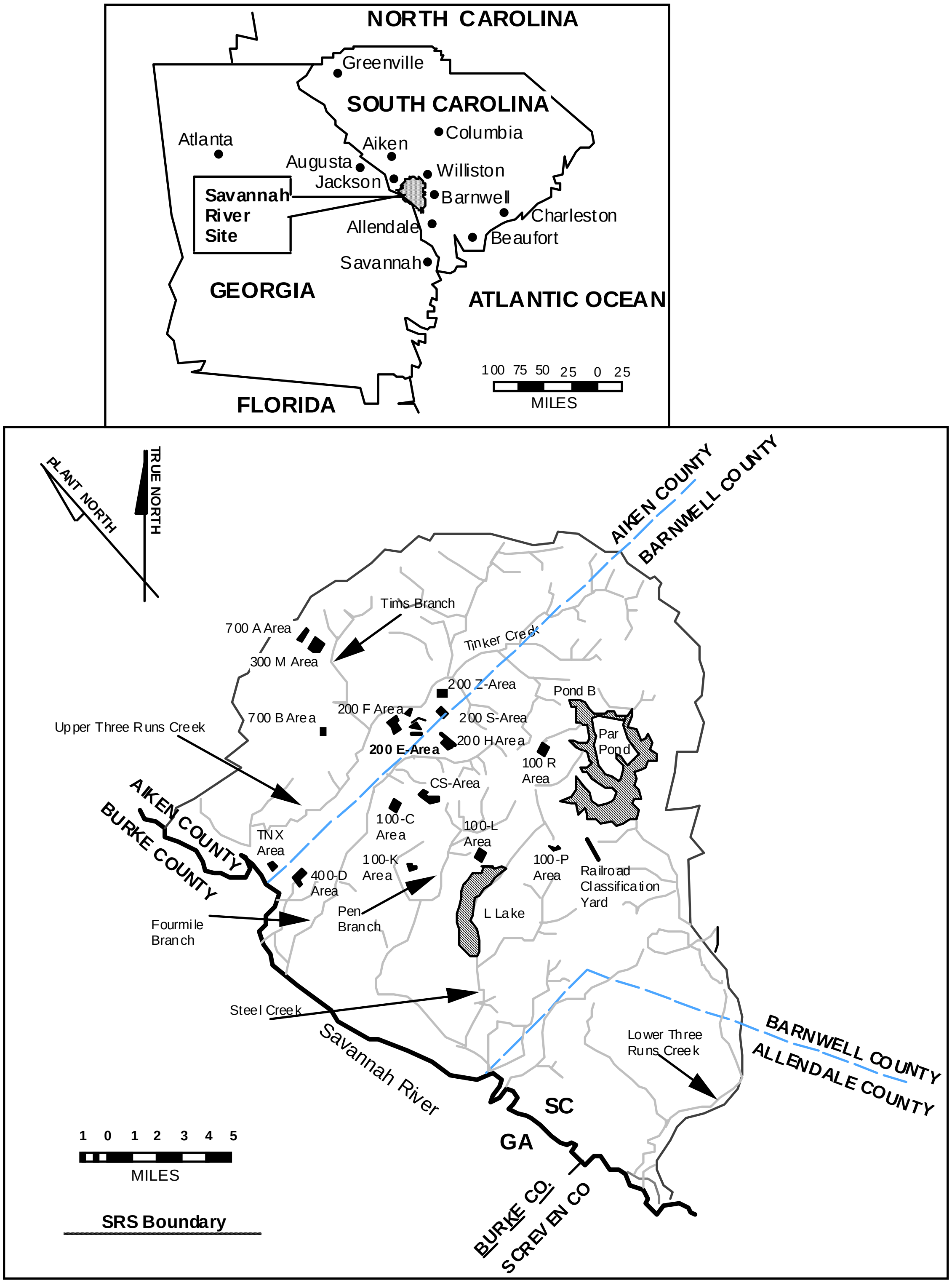


Figure 1.1-2 Location of SRS

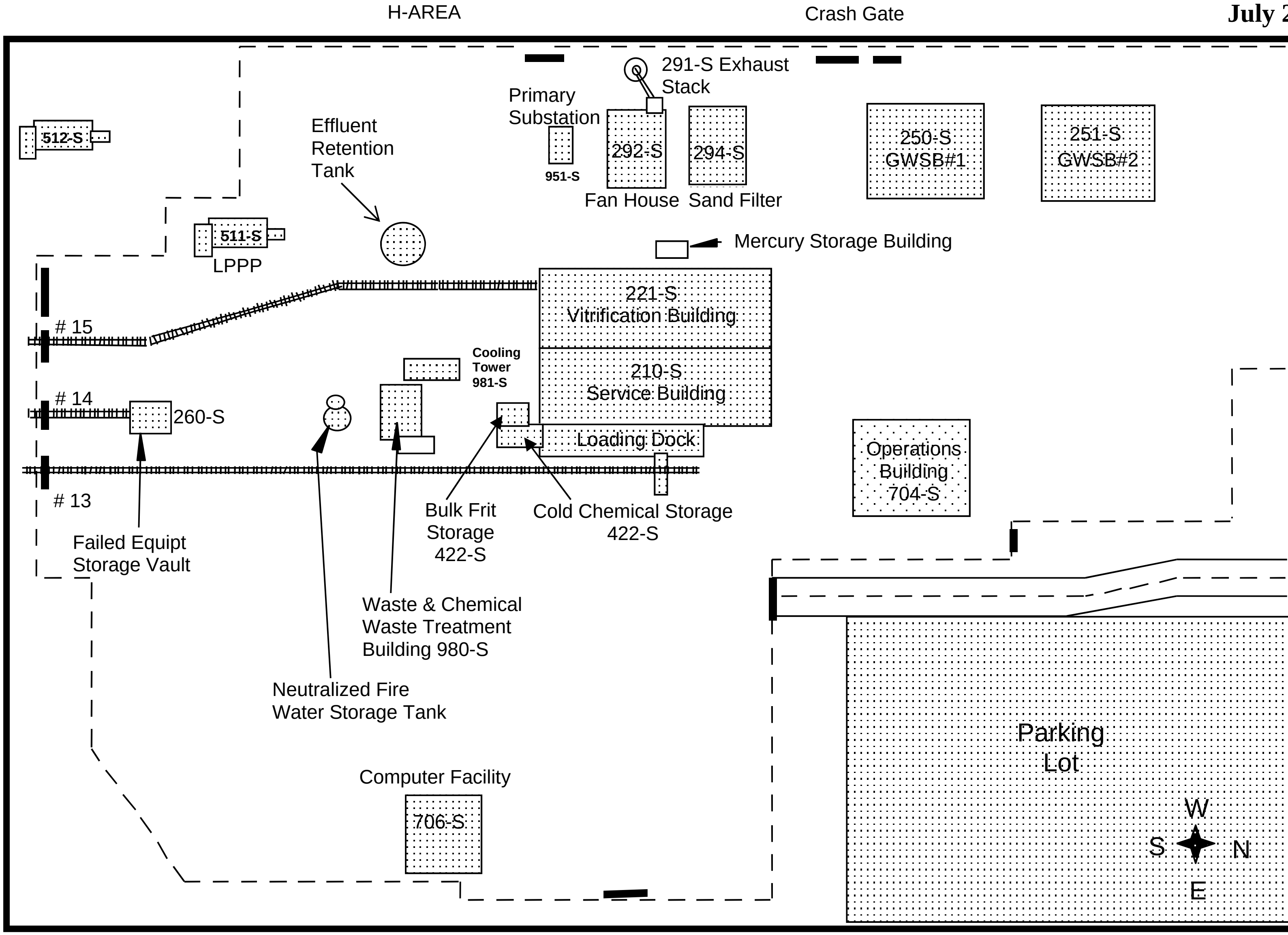


Figure 1.2-1 DWPF Layout

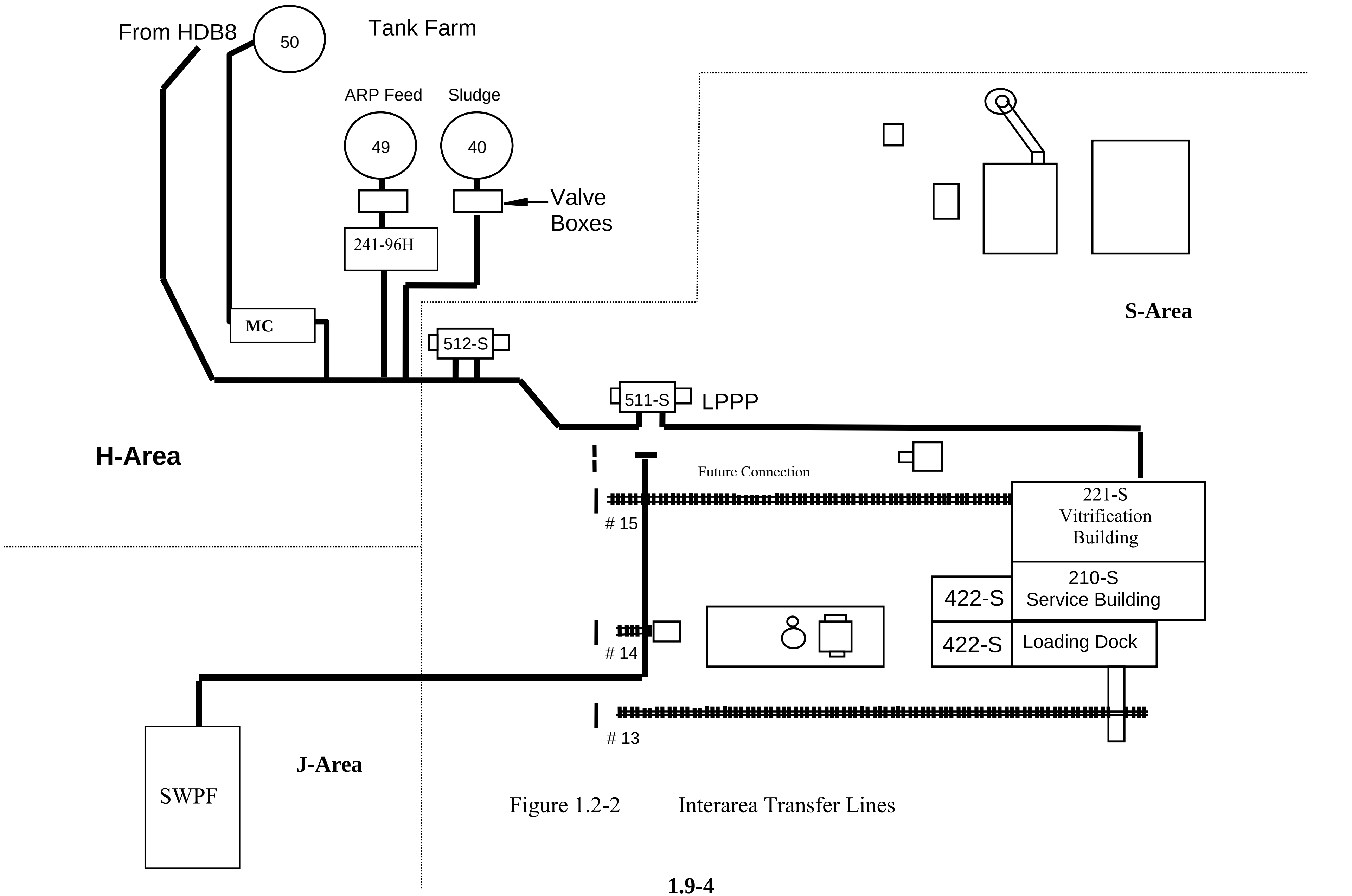
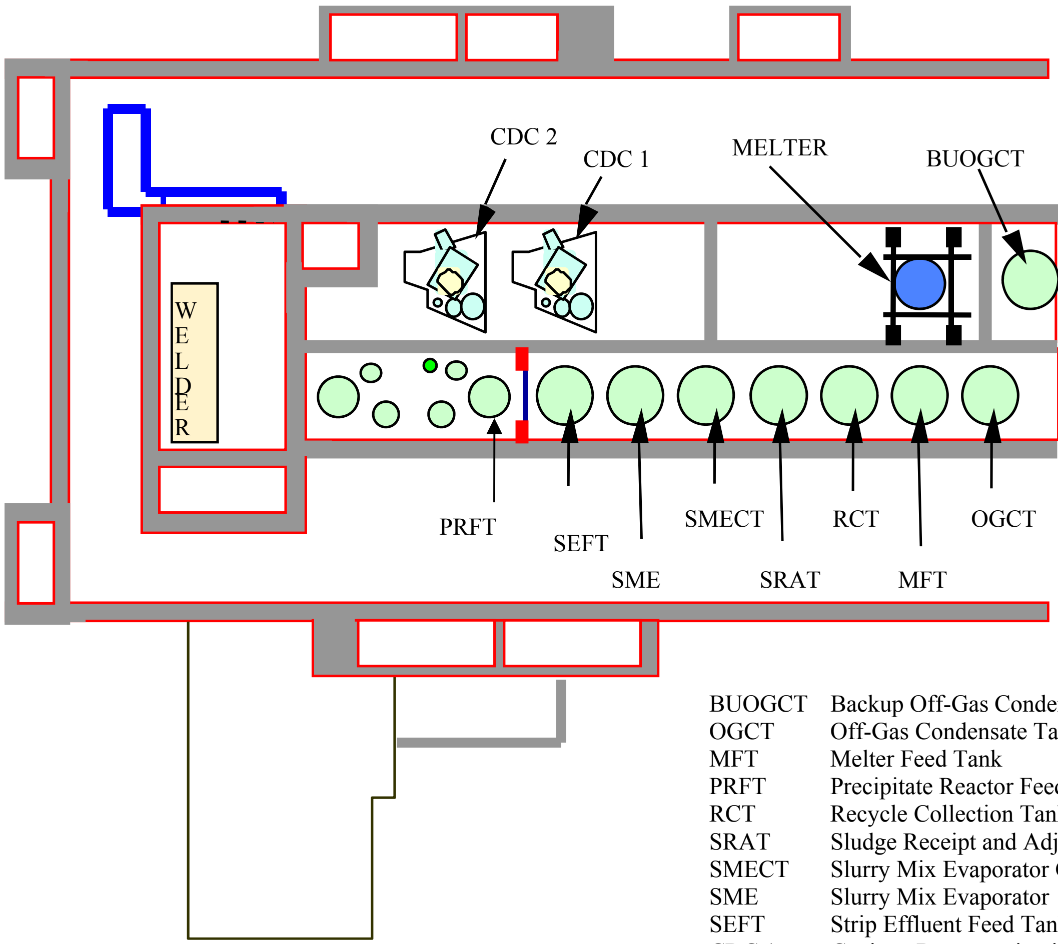


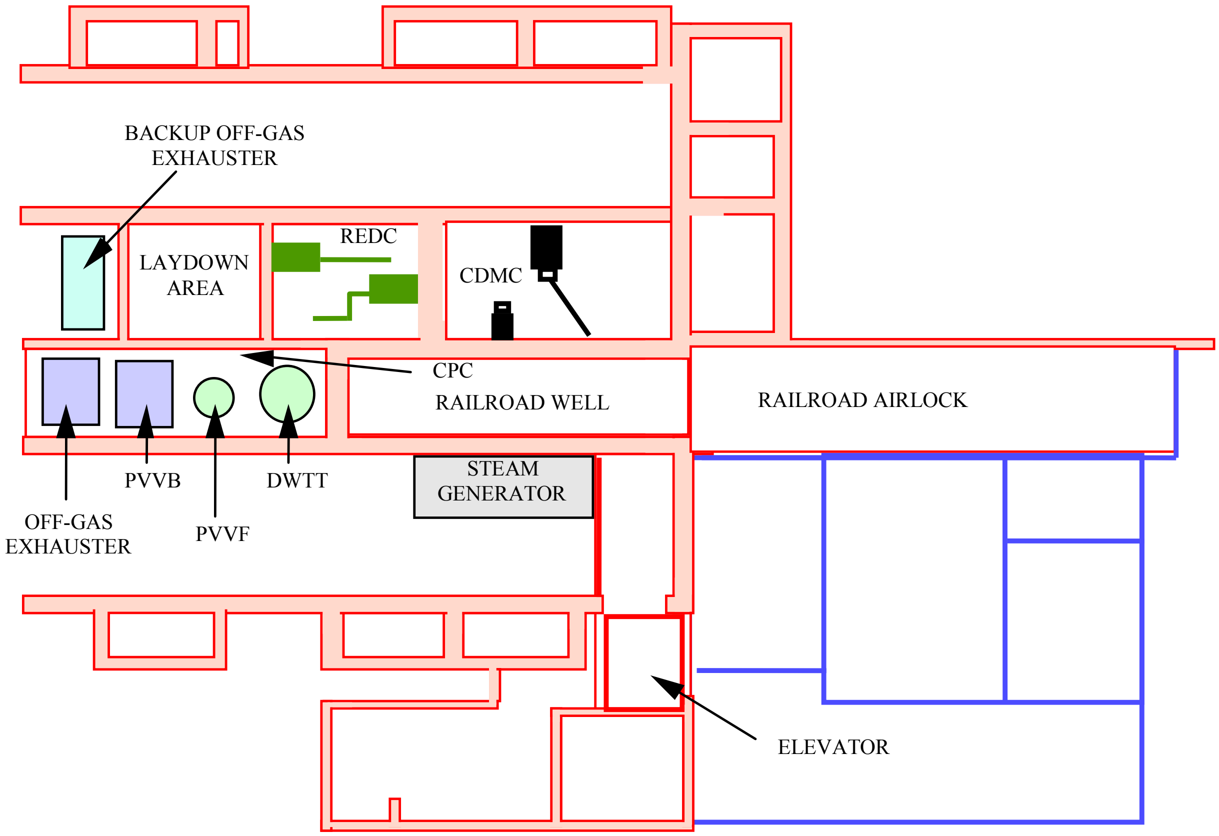
Figure 1.2-2 Interarea Transfer Lines

Figure 1.2-3 Deleted



BUOGCT	Backup Off-Gas Condensate Tank
OGCT	Off-Gas Condensate Tank
MFT	Melter Feed Tank
PRFT	Precipitate Reactor Feed Tank
RCT	Recycle Collection Tank
SRAT	Sludge Receipt and Adjustment Tank
SMECT	Slurry Mix Evaporator Condensate Tank
SME	Slurry Mix Evaporator
SEFT	Strip Effluent Feed Tank
CDC 1	Canister Decontamination Chamber 1
CDC 2	Canister Decontamination Chamber 2

Figure 1.2-4 Vitrification Building - Level 1 - North End



DWTT Decontamination Waste Treatment Tank
PVVF Process Vessel Vent Filter
PVVB Process Vessel Vent Blower
REDC Remote Equipment Decon Cell
CDMC Contact Decon Maintenance Cell
CPC Chemical Process Cell

Figure 1.2-5 Vitrification Building- Level 1 South End

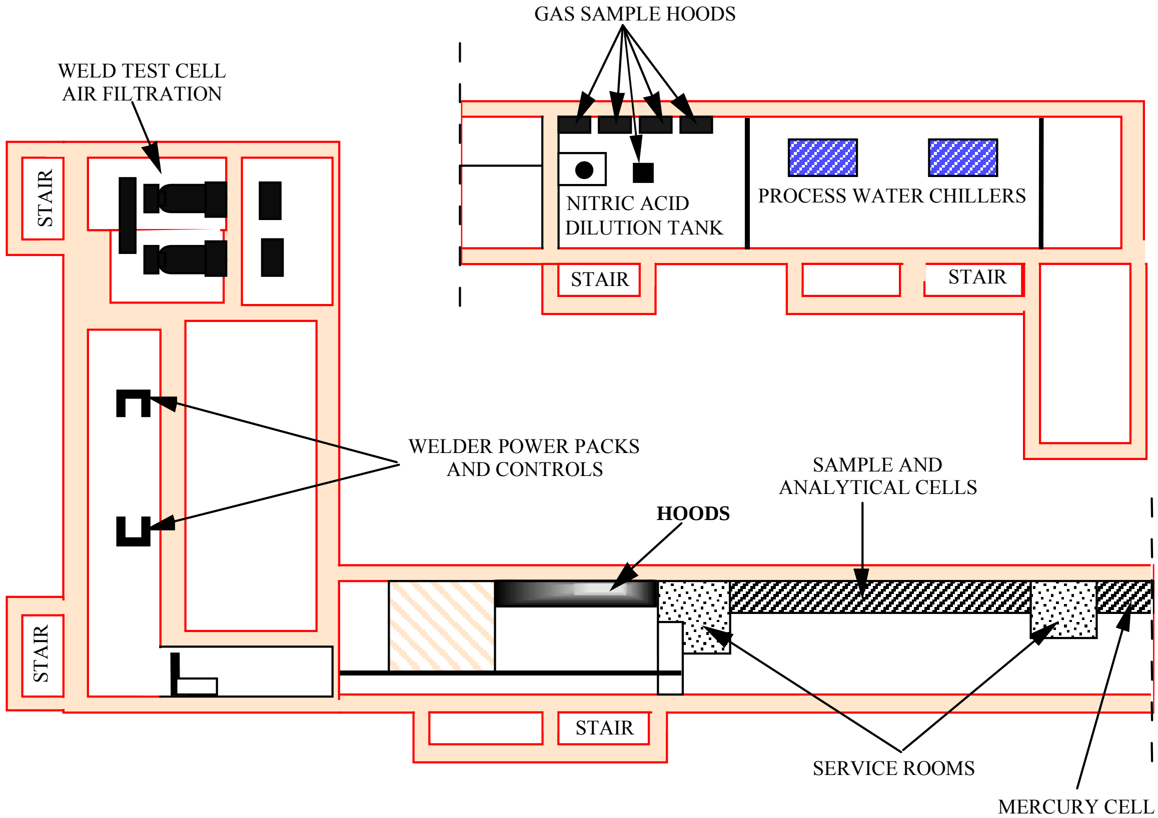


Figure 1.2-6 Vitrification Building-Mezzanine Level

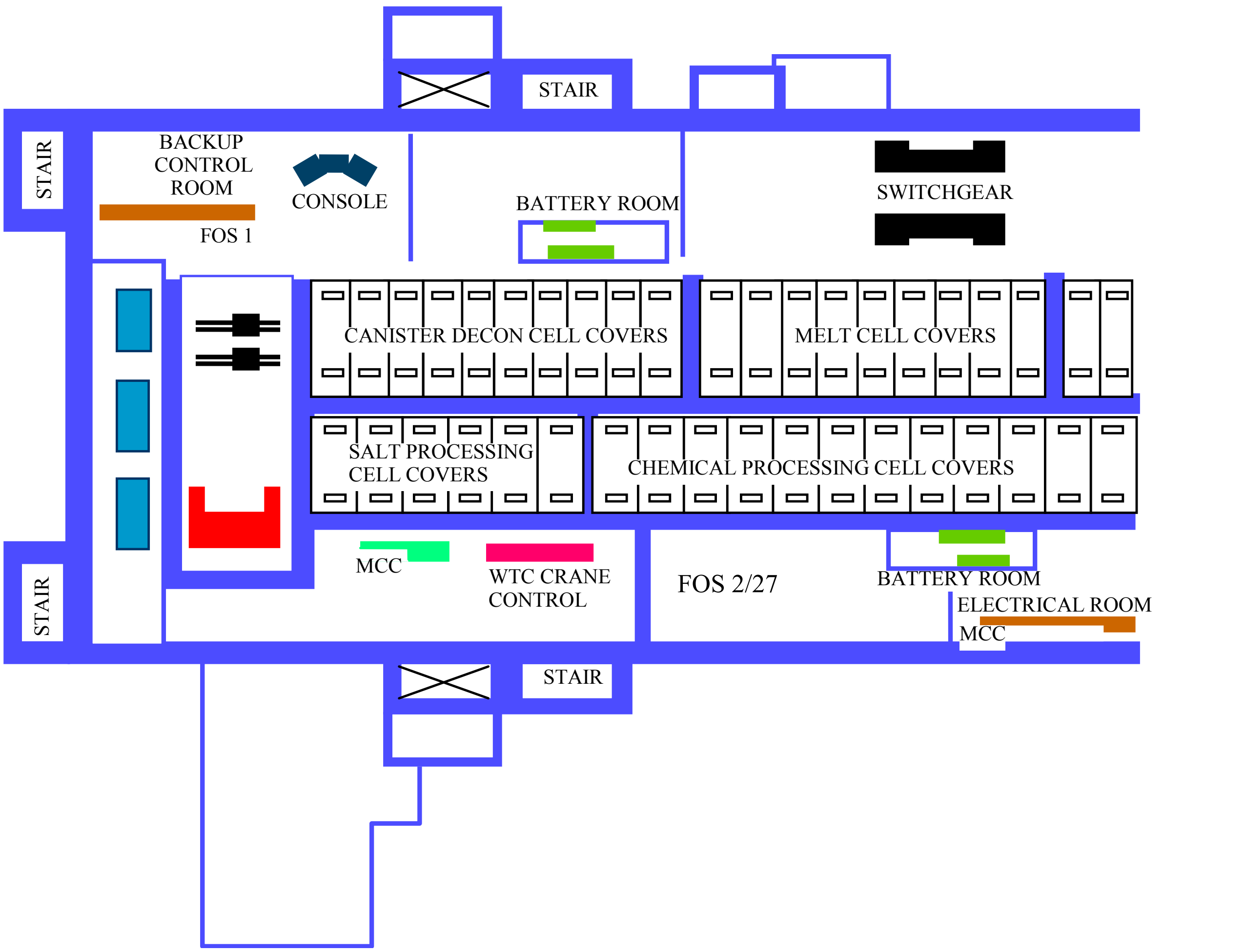


Figure 1.2-7 Vitrification Building - Level 2 - North End

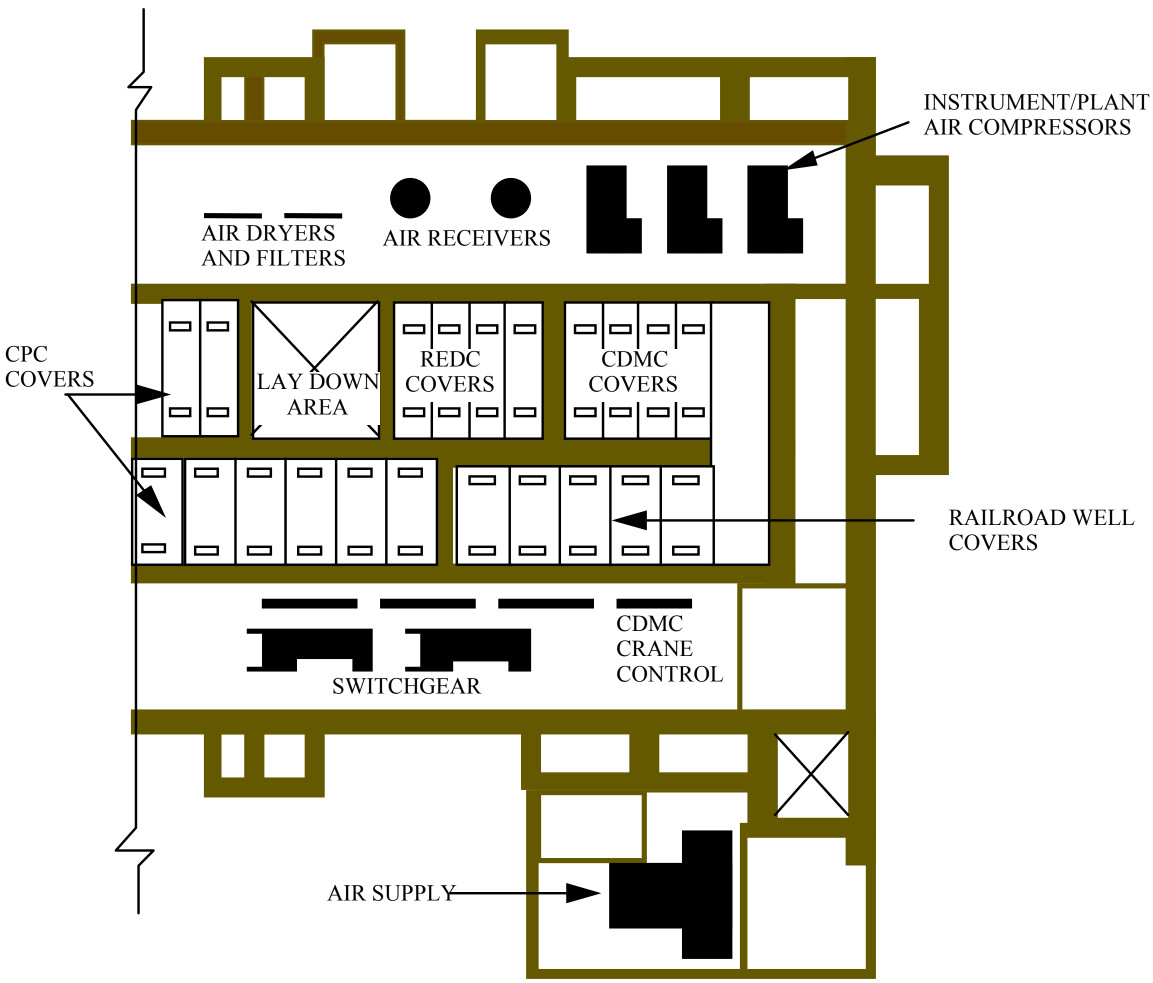


Figure 1.2-8 Vitrification Building-Level 2-South End

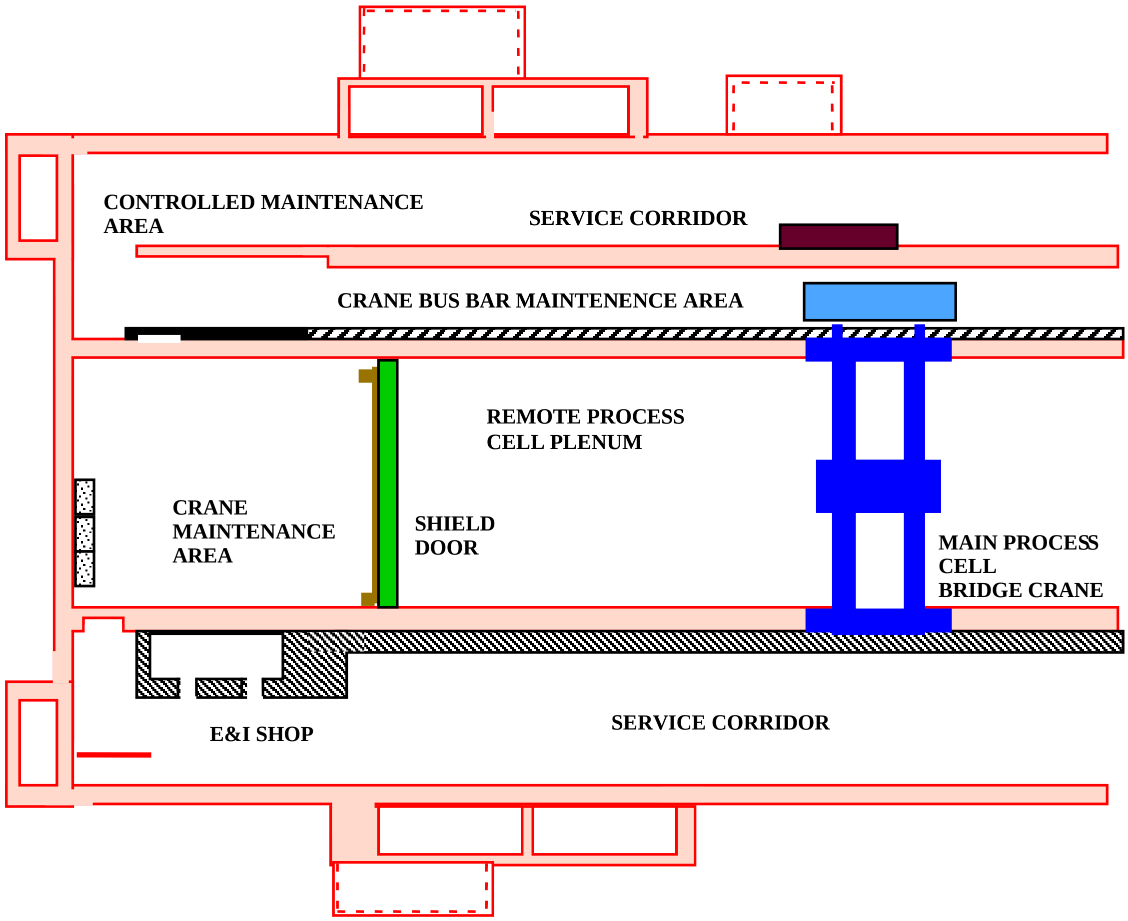


Figure 1.2-9 Vitrification Building-Level 3-North End

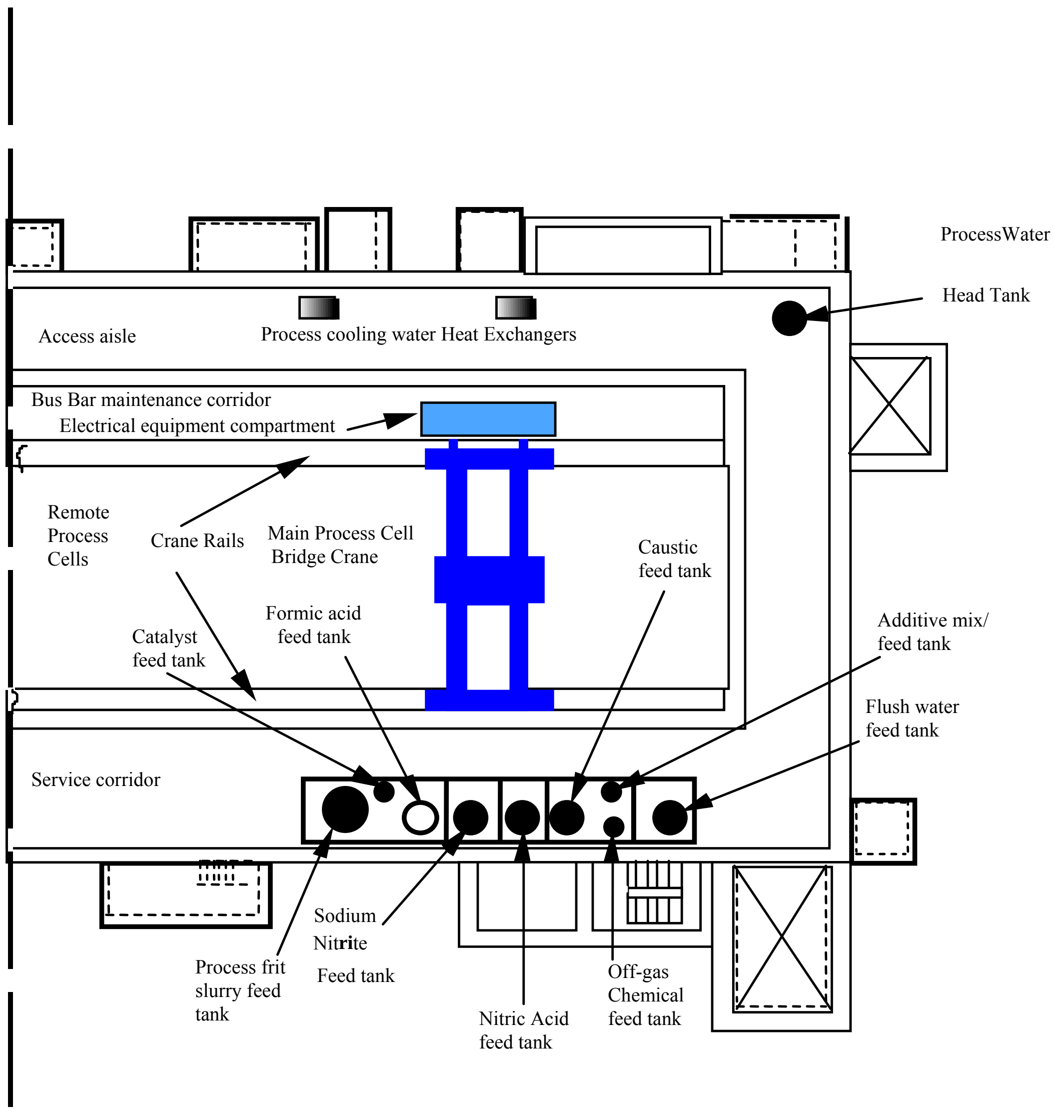


Figure 1.2-10 Vitrification Building Level 3 - South End

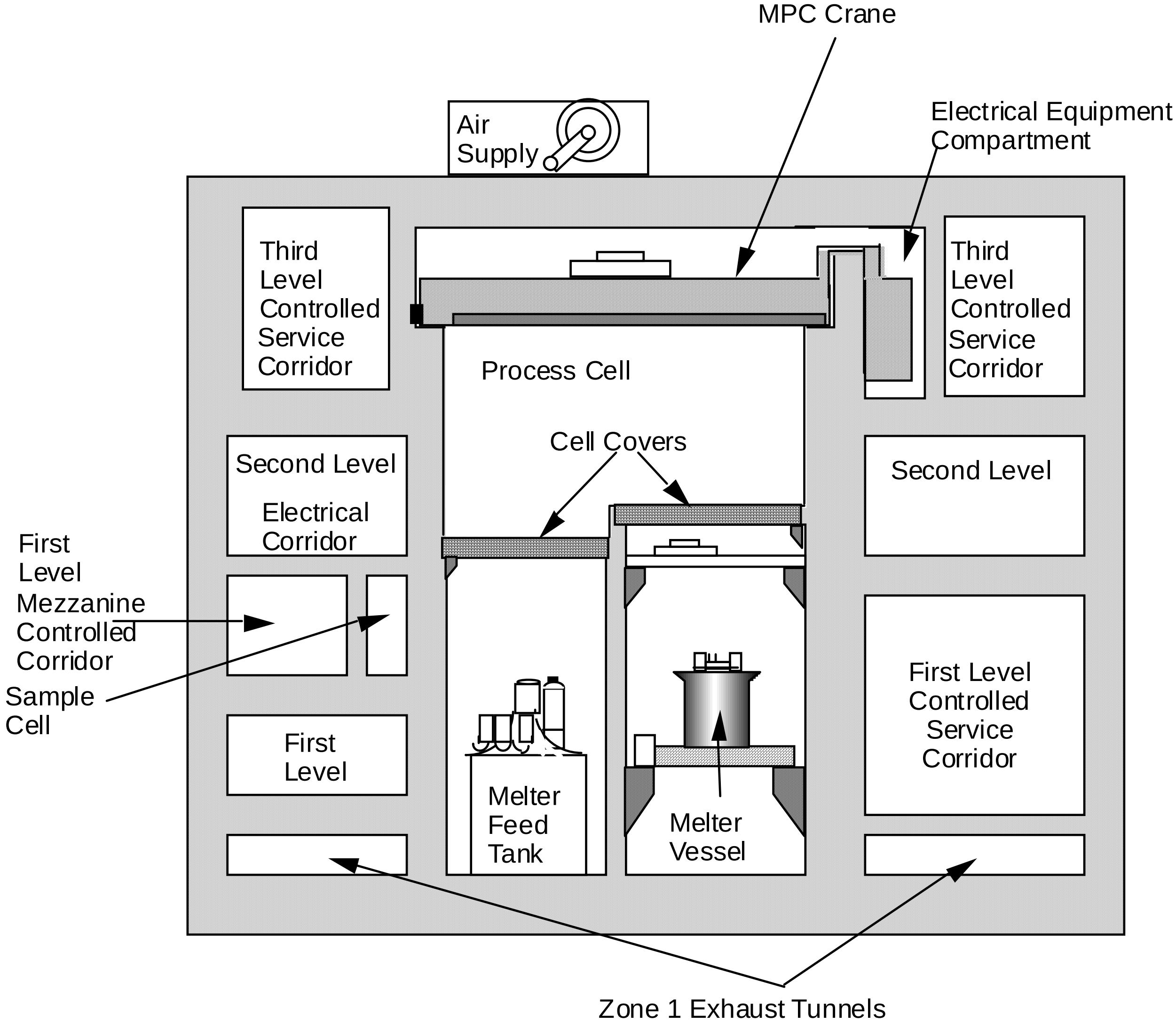


Figure 1.2-11 Vitrification Building Cross Section Through Melt Cell

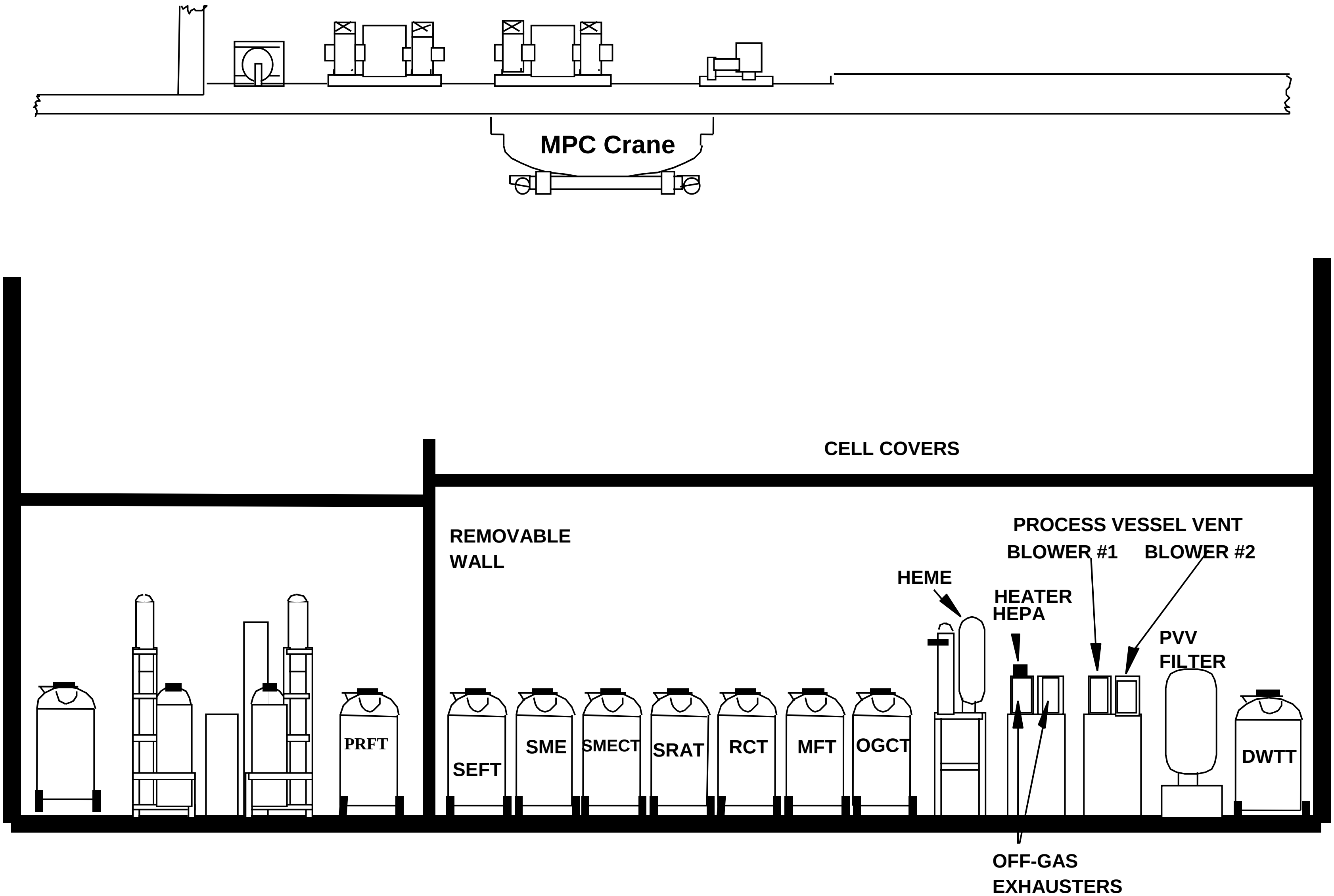


Figure 1.2-12 Long X-Section CPC Component Locations

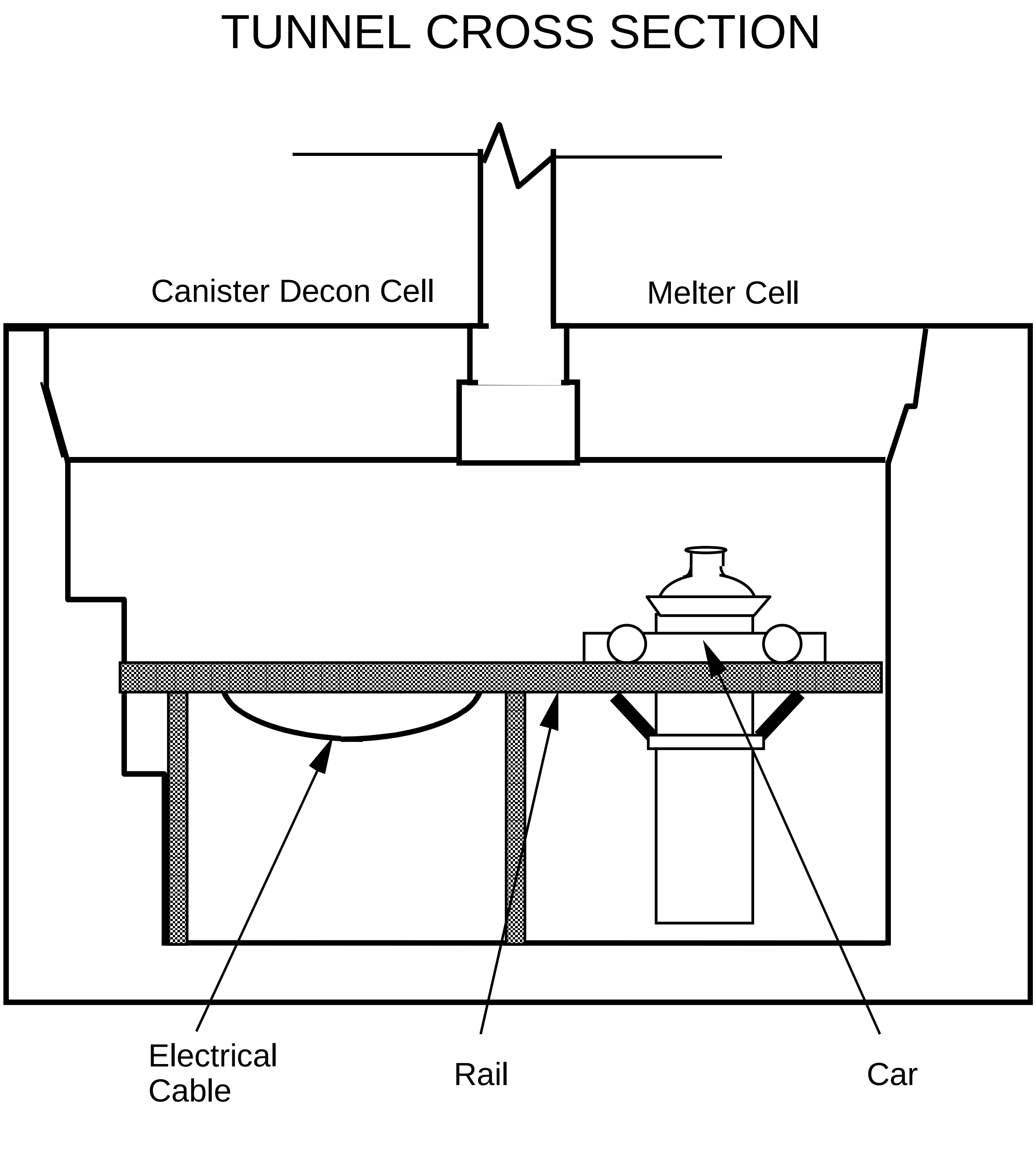


Figure 1.2-13 Melt Cell to Canister Decontamination Cell Transfer Tunnel

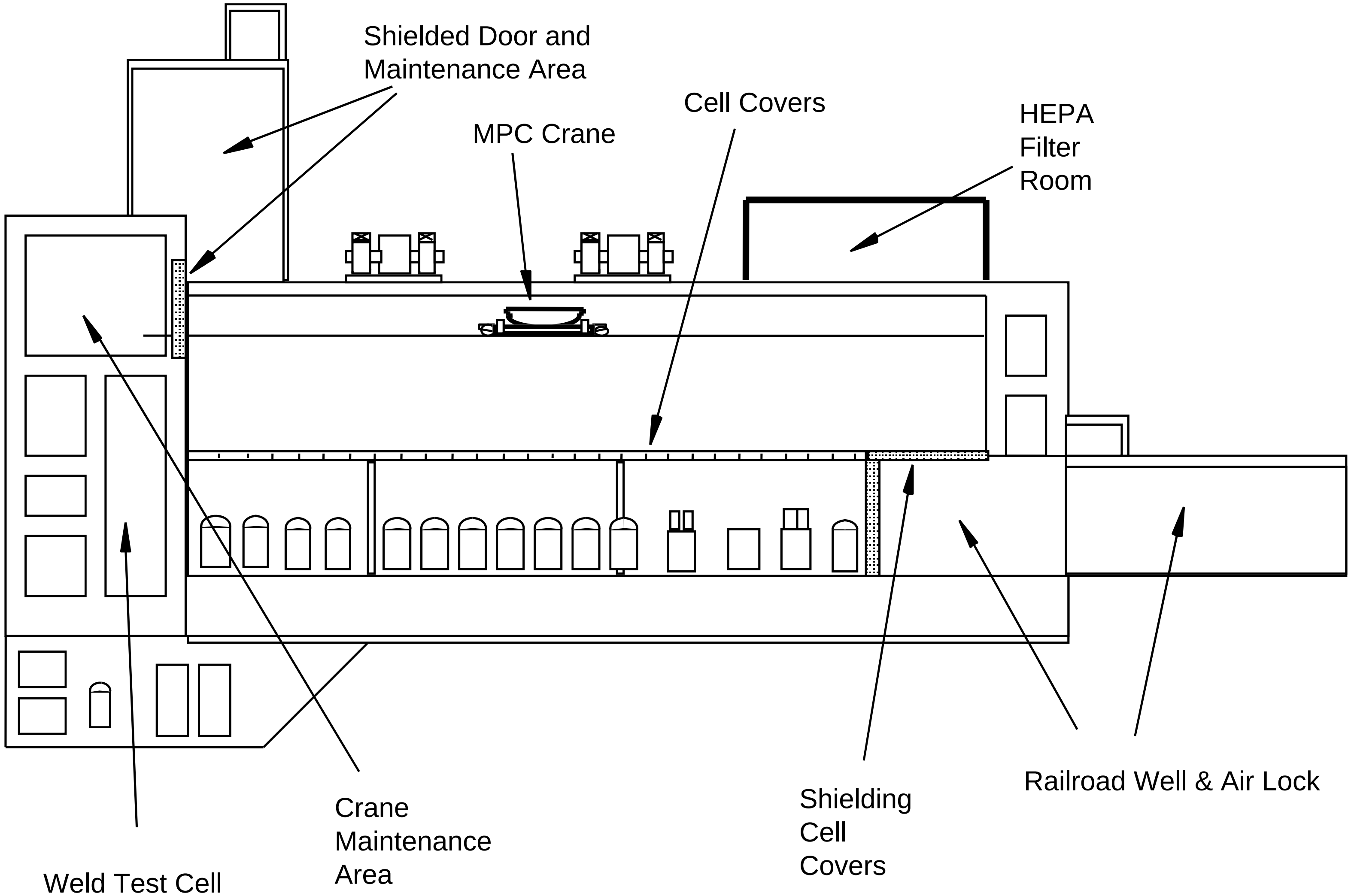


Figure 1.2-14 Vitrification Building - Longitudinal Section

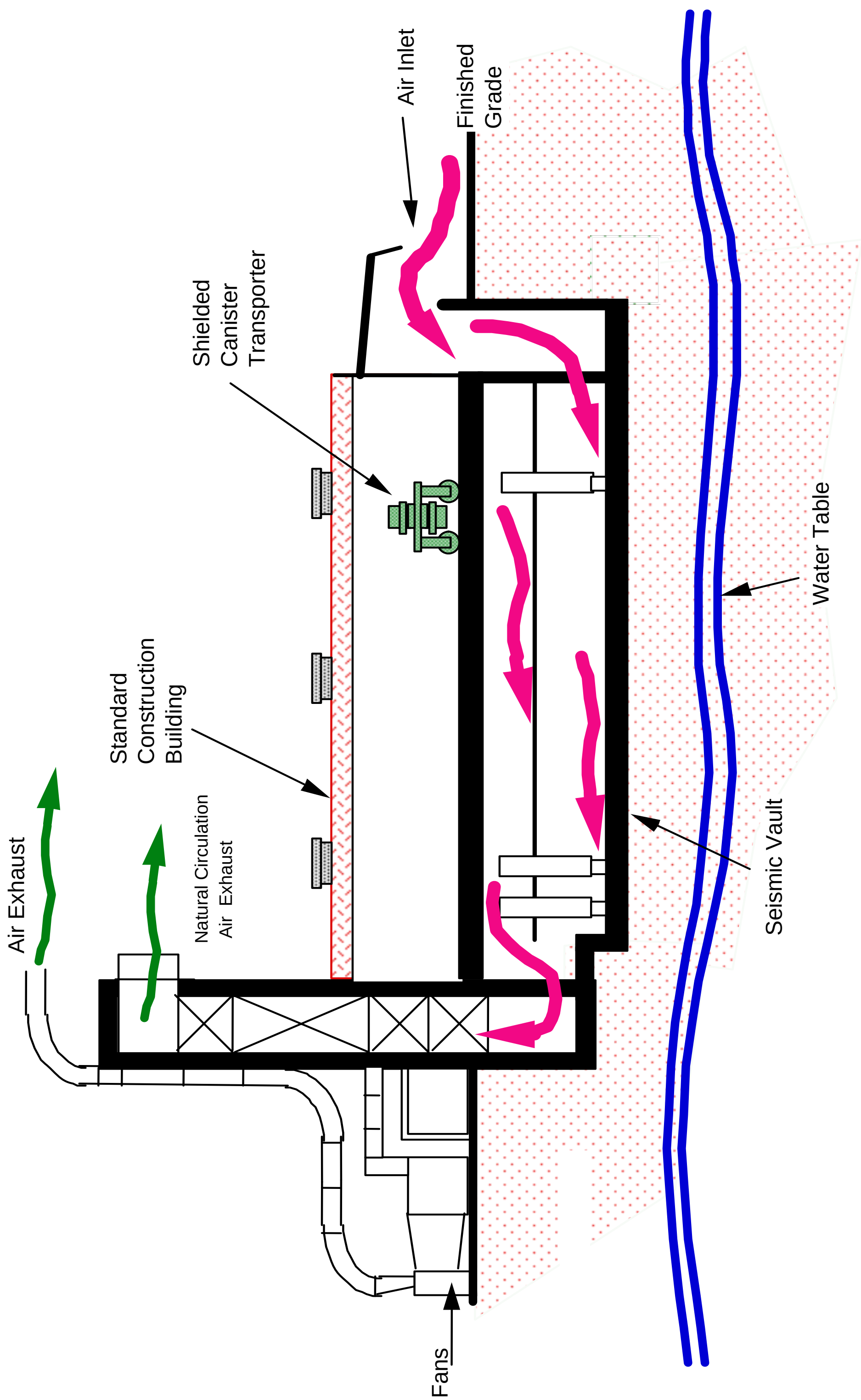


Figure 1.2-15 Glass Waste Storage Building #1 Cross Section

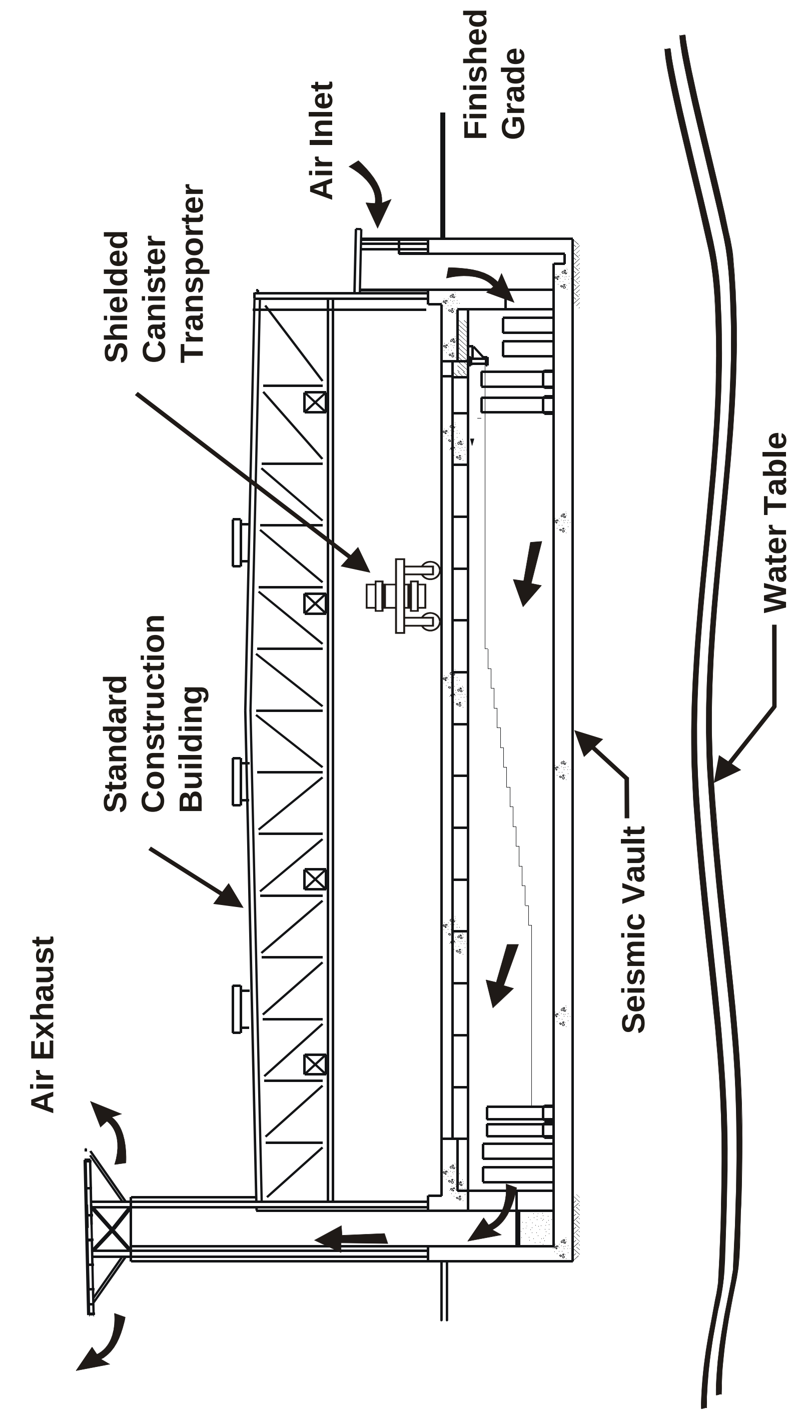


Figure 1.2-15a Glass Waste Storage Building # 2 Cross Section

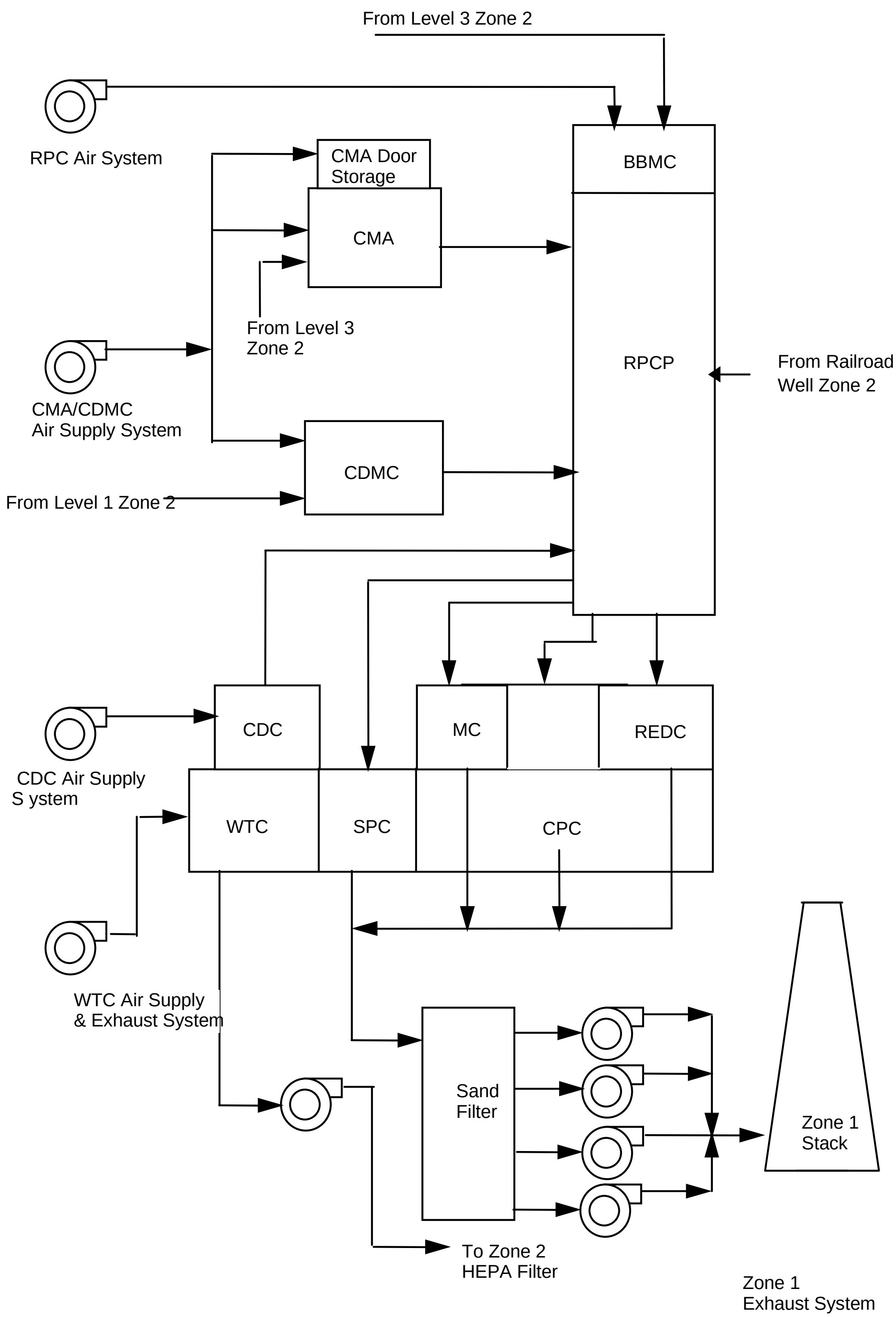


Figure 1.2-16 Zone 1 Air Flows

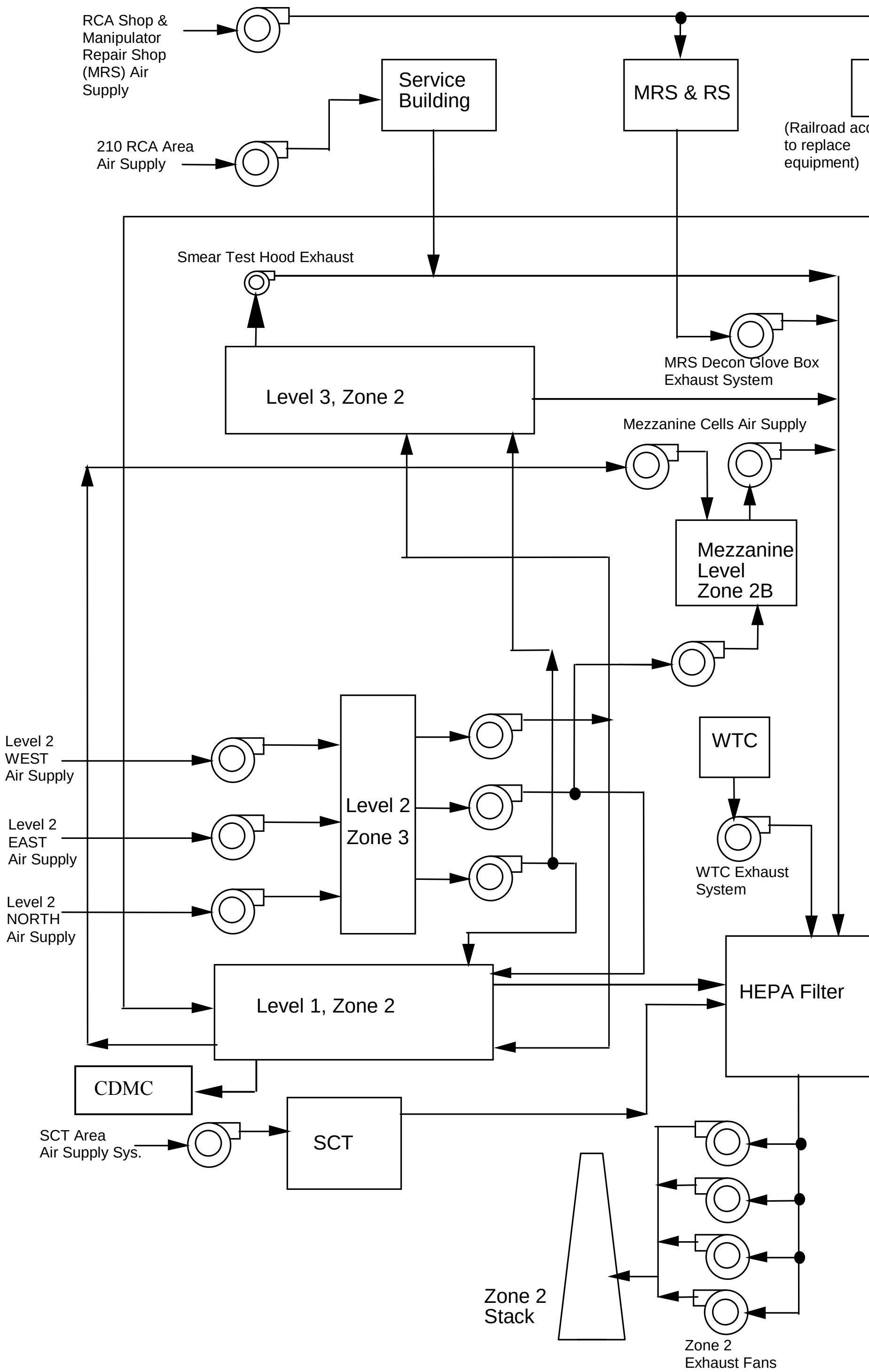


Figure 1.2-17 Zone 2 and 3 Air Flows

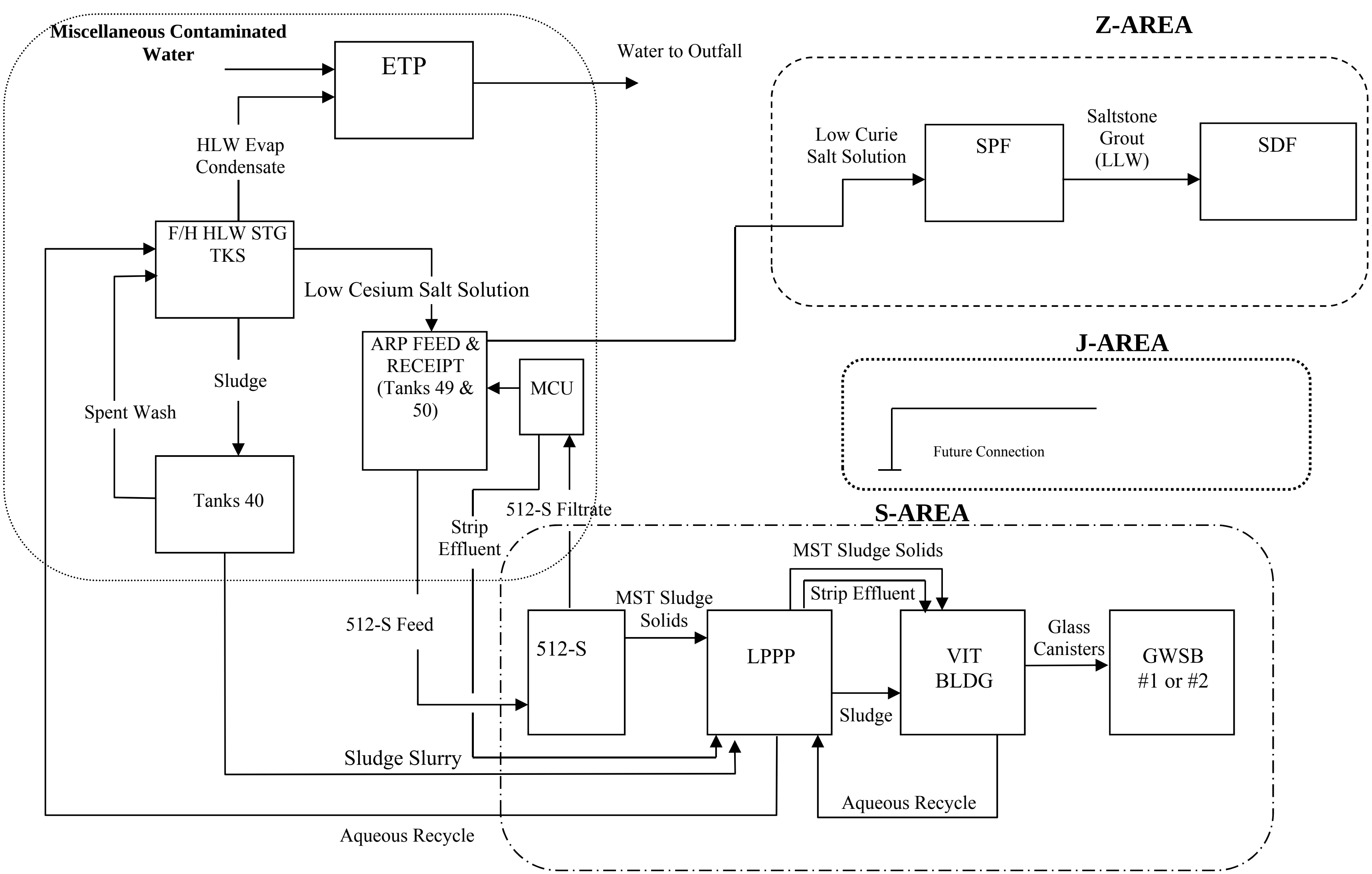


Figure 1.4-1 The DWPF Process and Relationship to Other Process Areas

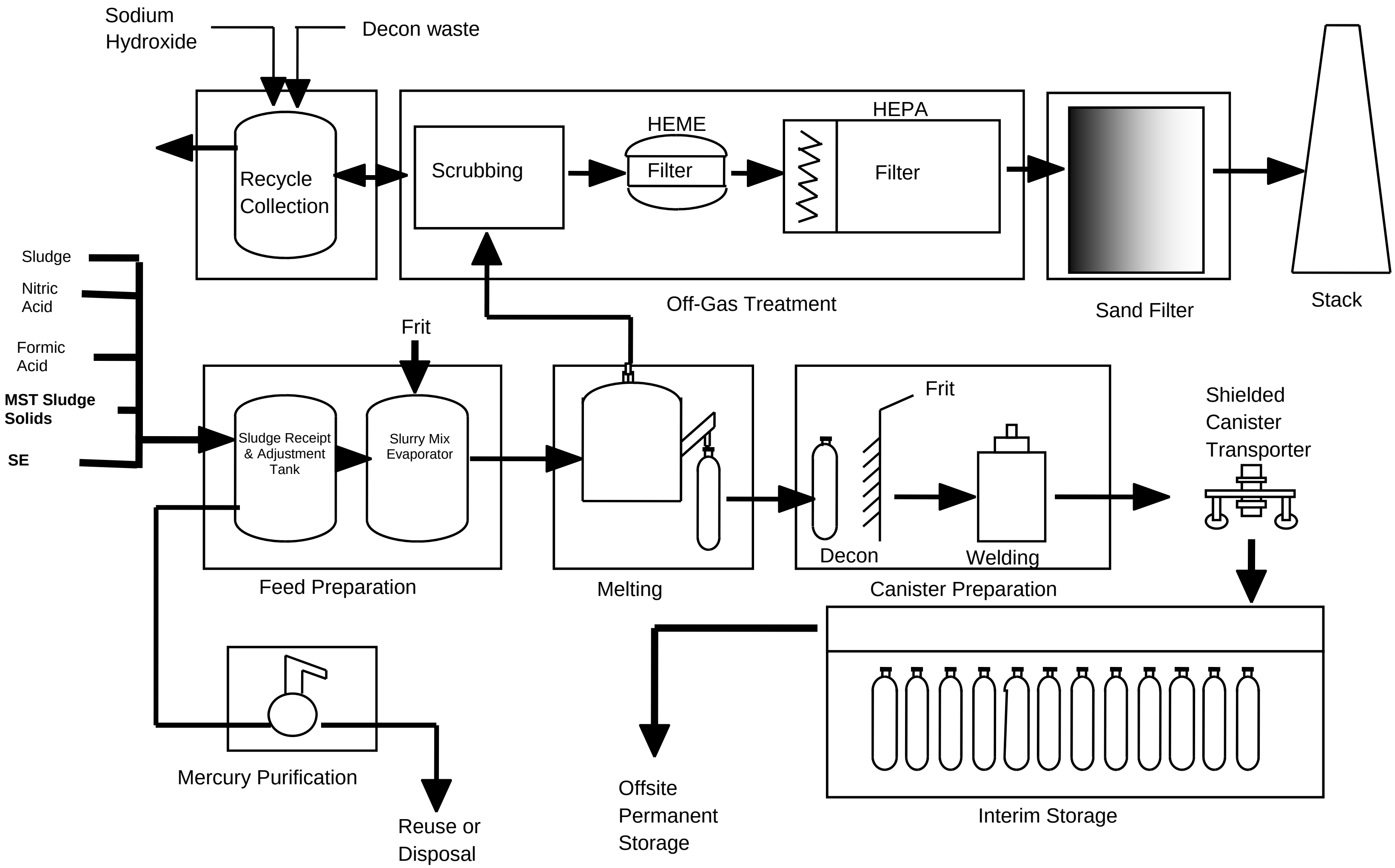


Figure 1.4-2 Vitrification Process

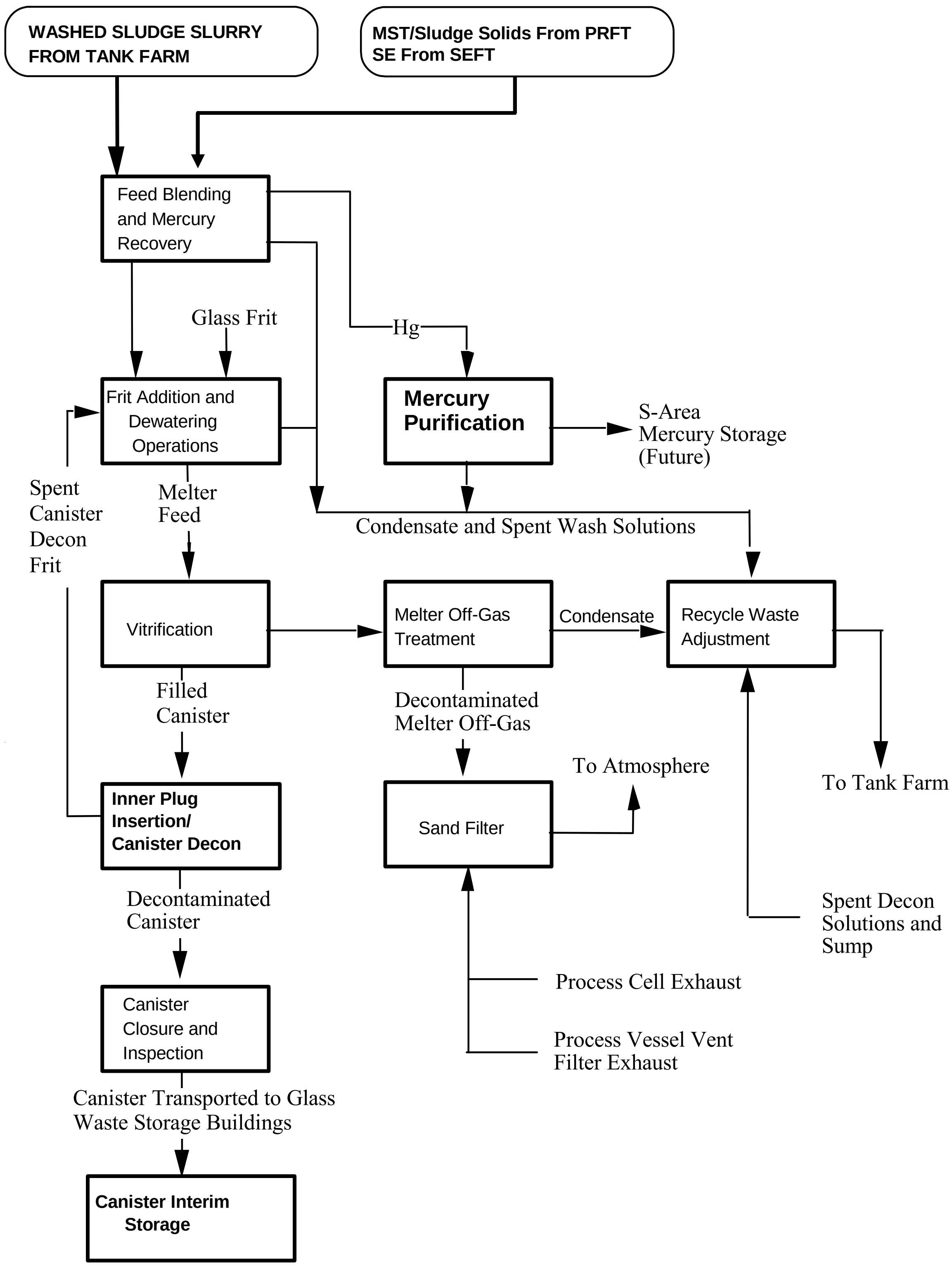


Figure 1.4-3 DWPF Process Block Flow Diagram

Table 1.0-1 DOE Orders Applicable to DWPF Startup

DOE Order Number	Subject	DOE Order Number	Subject
1300.2A	DOE Tech Stds Prog	5480.18B	Training Accreditation
1360.2B	Unclassified Computer Security Program	5480.19	Conduct of Ops
1540.2	Haz Mat'l Pkg Trans. Admin Proc's	5480.20A	Training
1540.3A	Base Tech Rad Mat'l Trans Pkg Systems	5480.21	USQs
4330.4B	Maintenance	5480.22	TSRs
4700.1	Project Management	5480.23	SARs
5000.3B	Occurrence Reporting	5480.24	Nuc. Criticality Safety
5400.1	General Environmental Compliance Program	5480.28	Natural Phenomena
5400.2A	Environmental Compl. Issue Coordination	5480.29	Employee Concerns
5400.4	CERCLA	5480.31	Startup/Restart of Nuclear Facilities
5400.5	Radiation Protection of Public & Environment	5482.1B	ESH Appraisal Program
5440.1E	NEPA	5483.1A	OSHA
5480.1B	Env., Safety, Health Programs	5484.1	Env Prot Reporting Requirements
5480.3	Safety Reqmts for Pkg and Trans of Haz Matl's	5500.1B	Emer. Mgmt System
5480.4	ESH Standards	5500.2B	Emer. Categories, Classes, Reporting
5480.7A	Fire Protection	5500.3A	Planning and Preparedness for Ops Emergencies
5480.8A	Medical Programs	5500.4A	Public Affairs
5480.9A	Construction Safety and Health	5500.7B	Vital Records Protection
5480.10	Industrial Hygiene	5500.10	Emer. Readiness Assurance Prog
5480.11	Rad Con Manual	5700.6C	QA
5480.15	DOE Lab Accreditation	5820.2A	Rad Waste Mgmt
5480.17	Site Safety Reps	6430.1A	General Design Criteria

FINAL SAFETY ANALYSIS REPORT
SAVANNAH RIVER SITE
DEFENSE WASTE PROCESSING FACILITY

CHAPTER 2

SUMMARY SAFETY ANALYSIS

July 2015

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2.0 SUMMARY SAFETY ANALYSIS

2.1 FACILITY HAZARD CLASSIFICATION

Hazard classification was determined for the Defense Waste Processing Facility (DWPF), and results are documented in the DWPF Preliminary Hazards Analysis (PHA) (Ref. 1). Further evaluation of the functional classification of safety related controls related to chemical processes identified by the PHA was performed in Reference 8. The 512-S hazard classification was determined by a Consolidated Hazard Analysis (CHA) and is documented in the Consolidated Hazard Analysis Process (CHAP) report (Ref. 3). The following additional hazards analyses have been performed:

- A Consolidated Hazards Analysis (CHA) was conducted for the Waste Transfer Line (WTL) Project to support operation of the Modular Caustic Side Solvent Extraction Unit (MCU) and Actinide Removal Process (ARP) and is documented in the Consolidated Hazard Analysis for WTL Project (Ref. 6).
- A CHA was conducted to evaluate hazards associated with confined hydrogen explosions in Non-Safety Related SSCs – Interaction Sources that could interact with Safety Related equipment (Ref. 7).
- A CHA was conducted to evaluate the hazards associated with the installation of bubblers to the DWPF melter (Ref. 9).
- A CHA was conducted to evaluate the hazards associated with the entry into the Remote Process Cell (RPC) to perform a repair to the Main Process Cell (MPC) crane bridge rail (Ref. 10).

Consistent with DOE Standard 1027, DWPF was segmented for purposes of hazard classification. These segments, listed in Table 9.3-4 were established in such a way as to reasonably ensure that hazardous material in one segment could not interact with those in other segments.

Glass Waste Storage Building #2, though not mentioned in the DWPF PHA (Ref. 1), is similar in construction to the GWSB #1. The accident scenarios and initiators are applicable to both of the GWSBs. While GWSB #2 was designed with slightly more storage locations, and therefore a higher source term for the canisters stored within GWSB #2, the only differences would be the slightly higher consequences of each credible accident evaluated. As such, the hazard classification for both of the GWSBs will be the same.

Segment 1 was defined to include the Vitrification Building, Sand Filter, Fan House, Zone 1 Exhaust Stack, Low Point Pump Pit and Bulk Frit Storage Facility, due to common piping and the associated potential for interaction. Based on exceeding radionuclide threshold quantities specified in DOE Standard 1027, Segment 1 was classified as a Category 2 facility. Segment 2, the 210-S Service Building, is, considered a below Category 3, non-radiological facility. The Glass Waste Storage Buildings are divided into three separate segments for hazard categorization, each independent and having a different material inventory. Segment 3, the GWSB #1 Vault area, and Segment 3a, the GWSB #2 Vault area, were assigned a Category 2 classification based on the combined radiological inventory of the filled canisters. Due to the lower contamination level anticipated in the regulated GWSB #1 and GWSB #2 Operations areas, Segments 4 and 4a were classified as a Category 3 radiological facility. The GWSB #1 Office area, Segment 5, and the GWSB #2 Electrical Room, Segment 5a, are free of radiological sources and were classified as a below Category 3, non-radiological facility. Segment 6, the Failed Equipment Storage Vault, was classified as a Category 2 facility based on anticipated exceedance of the Cs-137 threshold specified in DOE Standard 1027. Segments 7 and 8, the Cold Chemical Feed Storage and Chemical and Industrial Waste Treatment Facilities, will not contain radiological sources. In accordance with DOE Standard 1027 guidance for non-radiological hazards, these segments were included as non-radiological Category 3 facilities. Segment 9, the 512-S, was classified as a Category 2 classification based on the radiological inventory.

Based on the classification of these segments, the DWPF was determined to be a Hazard Category 2 facility. See Section 9.3.2.2 for more details on DWPF hazard classification.

2.2 SAFETY ANALYSIS OVERVIEW

DWPF operations involve risk of fire, explosion, uncontrolled chemical reactions, and spills, as identified in the DWPF PHA (Ref. 1). Further details of significant hazards associated with operation of DWPF are presented in Section 9.3. Chapter 9 of the Final Safety Analysis Report documents the results of analyses for frequency and consequences of these accidents.

The hazard analyses presented in Section 9.3 are used as the basis for identification of safety significant Structures, Systems, and Components (SSCs) and administrative controls to protect the onsite worker. The design basis analyses presented in Section 9.4 are used as the basis for identification of safety class SSCs and administrative controls to protect the offsite public. The safety SSCs, administrative controls, Technical Safety Requirements (TSRs), and supporting hazard and design basis analyses establish the Safety Authorization Basis for the DWPF. This set of safety items, analyses and TSRs is the basis for the conduct of safety evaluations for determining the existence of an Unreviewed Safety Question per DOE Order 5480.21. Summary descriptions of the Safety Class (SC) and Safety Significant (SS) SSCs are provided in Chapter 4, Tables 4.3-1 (SC) and 4.4-1 (SS). Administrative controls are described in Chapter 11, Section 11.5.11.

A Probability Safety Assessment (PSA), WSRC-TR-95-0198, June 1995 of the DWPF was performed. The PSA provides a safety perspective which considers significant initiators and analyzes the progressions to top events. The PSA is not considered part of the Authorization Basis but provides a separate verification of the adequacy of the facility design by modeling all relevant safety class, safety significant and non-safety SSCs as well as operator actions.

A brief description of the DWPF process, hazards, and preventative and mitigative SSCs are discussed below. Safety Class SSCs are installed to prevent or to mitigate the consequences from accidents that would otherwise exceed the offsite Evaluation Guidelines (EGs) without the installation of the Safety Class SSCs. Likewise, Safety Significant SSCs are installed to prevent or mitigate consequences from accidents that would exceed the onsite threshold of concern but would not exceed offsite EGs. Safety Significant SSCs protect the facility worker and other onsite personnel. The Safety Class SSCs protect the offsite public and inherently protect the onsite and facility workers. A complete list of safety class and safety significant SSCs as well as a comprehensive description of the safety function is provided in Chapter 4, Safety Structures, Systems, and Components and Chapter 9, Hazard and Accident Analysis.

Sludge from the H-Area Concentration, Storage, and Transfer (CST) Facility and MST/Salt Solution from H-Area are transferred to the Low Point Pump Pit (LPPP) and the 512-S respectively via the interarea transfer lines. The CST Facility removes soluble salts from the sludge material. Salt solutions containing high levels of strontium and actinides may be treated with monosodium titanate (MST) prior to being transferred from H-Area (via either the 241-96H Facility or directly from Tank 49) to the 512-S where it undergoes filtration to remove the MST (if utilized) and sludge solids. The non-soluble actinides and are removed by filtration in the 512-S. When a batch containing the proper solids content of MST/Sludge Solids is achieved, it is transferred to the DWPF via the LPPP.

Interarea transfer lines (underground) are used to transfer Sludge, 512-S feed, MST/Sludge Solids, recycled waste, Decontaminated Salt Solution (DSS), Strip Effluent (SE), and Filtrate. The sludge material is transferred from the CST Facility to the LPPP, and then to the DWPF Chemical Processing Cell (CPC). 512-S feed is transferred from H-Area to 512-S where it undergoes filtration/concentration. The concentrated MST/Sludge Solids are transferred to the 221-S via the LPPP. Filtrate from 512-S is transferred back to H-Area (MCU) for additional processing to remove the Cs-137 as required. The MCU stream enriched with Cs-137, Strip Effluent (SE), is then sent through interarea transfer lines via a LPPP cell to DWPF for vitrification. The second stream from MCU, Decontaminated Salt Solution (DSS), is sent via interarea transfer lines to H-Area (Tank 50). Recycled waste solutions are pumped from the Recycle Collection Tank in the CPC to the LPPP and then to H-Area. These transfer lines are stainless steel and encased in a carbon steel jacket. The annulus is monitored for leaks.

The Vitrification Building (221-S) is designed to withstand the Design Basis Earthquake (DBE) and the Design Basis Tornado (DBT). The 221-S building is not designed to withstand an internal explosion; however, the CPC safety class purge systems preclude an explosion from occurring in the vessels.

The CPC receives the sludge slurry from the LPPP. The sludge slurry is acidified with nitric acid. Formic acid is added to facilitate removal of mercury and to prevent excessive foaming in the melter. MST/Sludge Solids and/or SE may be added. Mercury in the slurry is removed during boiling operations. Glass frit is then added to the slurry product and excess water is evaporated. Off-gases from CPC and SPC processes are predominantly CO_2 and NOx. Hydrogen, ammonia, and solvent components (mainly Isopar L) from the MCU process are also generated in the CPC and SPC operations. The Process Vessel Ventilation (PVV) system collects, decontaminates, and discharges the gases from the in-cell processes to the Zone 1 exhaust system.

The CPC and SPC vessels liquid phase contains radioactive materials, hydrogen in solution, Isopar L which also migrate to the vessel vapor spaces. Two purge systems prevent explosions in the vessels by diluting the potentially flammable components below the composite lower flammability limit (CLFL) in the vessel vapor space. These systems are the CPC Primary Purge System (air/nitrogen) and the CPC Safety Grade Nitrogen System.

The Zone 1 Ventilation system provides a safety significant function to mitigate the consequences of a vessel spill, overflow or explosion in the Vitrification Building.

The vitrification, fanhouse, and sand filter structures and the diesel generator system provide support to assure operation of the ventilation system during a seismic, high wind, or loss of power event.

Sludge is adjusted in the Sludge Receipt and Adjustment Tank (SRAT), mixed with a glass frit in the Slurry Mix Evaporator (SME) and then fed to the Melter Feed Tank (MFT). It is fed from the MFT in the CPC to the joule-heated melter. Melter electrodes and dome heaters provide the energy required to dry and vitrify the solids. The melter vapor space can contain H2 and CO if organic compounds are not completely oxidized. TSR limits are set on the melter feed contents to ensure the composition of the feed is within the bounds of the melter flammability assessment.

The temperature of the melter vapor space is monitored with safety class equipment to ensure adequate combustion of hydrocarbons. Safety class hardwired interlocks to the melter feed pumps from low combustion air supply, low off-gas dilution air, low steam pressure or low plenum temperature are installed to prevent combustible vapors in the melter off-gas. Molten glass is poured into stainless steel canisters. These canisters are sealed with a temporary plug, and transferred to the Canister Decontamination Cell (CDC).

In the CDC, the potentially contaminated canister is decontaminated and then surveyed in the smear test station. Canisters are normally welded closed in the Weld Test Cell and transported to one of the Glass Waste Storage Buildings (GWSB #1 or GWSB #2) via the Shielded Canister Transporter (SCT). Alternatively, canisters may be temporarily stored in the GWSBs without final closure welds and returned to the Weld Test Cell for final closure. The GWSBs vaults and canister supports are Safety Significant to prevent stored canisters from being crushed and their contents released during a DBE.

Chemical feed and drain collection vessels containing nitric acid and formic acid are housed in the vitrification building and are connected to the radiological process vessels. Release of the contents does not pose an offsite threat but can harm onsite workers. These vessels and the dikes are designated safety significant to prevent and contain the hazardous vessel contents and prevent impact on radiological processes. Chemical storage and waste treatment vessels are present in the chemical storage and waste treatment areas. These vessels do pose a hazard to onsite workers, but are not a part of the radiological processes. These vessels have been determined to be standard industrial hazards (Ref. 8).

2.3 SAFETY ANALYSIS CONCLUSIONS

The DWPF safety analysis has considered a range of operating conditions, including normal, abnormal, and accident conditions and has demonstrated that the design and planned operations present an acceptable level of risk to onsite workers, facility workers, the offsite public, and the environment from chemical and radiological hazards. The hazard and accident analyses demonstrate that design features, administrative controls, and safety programs are in place to protect onsite workers, facility workers and the offsite public, provide defense in depth and reduce the potential for large releases to the environment. Safety SSCs and TSRs have been identified to establish the facility safety basis. Furthermore, it is shown that if the TSRs are followed and the safety class SSCs perform their functions, the radiological and chemical offsite consequences are within the evaluation guidelines as shown in Tables 9.1-1 and 9.1-2. The chemical consequences shown in Tables 9.1-2 and 9.1-3 are unmitigated and do not credit any safety class SSCs or TSRs.

2.4 REFERENCES

1. Defense Waste Processing Facility Preliminary Hazards Analysis (U). WSRC-TR-94-0586, Rev. 0.

2. Deleted.

3. 512-S Facility and Defense Waste Processing Facility Transfer Lines Consolidated Hazard Analysis (U). WSRC-TR-2002-00223, Rev. 5.

4. Deleted.

5. Deleted.

6. Consolidated Hazards Analysis for the Defense Waste Processing Facility (DWPF): Modular CSSX Unit (MCU)/241-96H Actinide Removal Process (ARP) Integration (Waste Transfer Line Project) (U), WSRC-TR-2006-00201, Rev. 4.

7. Consolidated Hazards Analysis for the Resolution of PISA: PI-05-006-NI-DWPF-05-001, WSRC-TR-2006-00417, Rev. 1.

8. Defense Waste Processing Facility (DWPF) Evaluation of Functional Classification of Chemical Controls, WSRC-TR-2007-00148, Rev. 0.

9. Defense Waste Processing Facility Melter Bubbler Consolidated Hazards Analysis, U-CHA-S-00001, Rev. 0.

10. Consolidated Hazards Analysis for Remote Process Cell Entry, U-CHA-S-00002, Rev. 0.

2.5 TABLES

Chapter 2 Tables Deleted