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FINAL SAFETY ANALYSIS REPORT

SAVANNAH RIVER SITE

DEFENSE WASTE PROCESSING FACILITY

VOLUME 4

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FINAL SAFETY ANALYSIS REPORT
SAVANNAH RIVER SITE
DEFENSE WASTE PROCESSING FACILITY

CHAPTER 5

FACILITY DESIGN

November 2018

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5.0 FACILITY DESIGN

Chapter 5 describes the DWPF in detail and explains how the criteria apply to the design. Features designed to maintain radioactive material confinement by withstanding natural events and onsite accidents are emphasized. DWPF occasionally undergoes outages and non-routine maintenance activities, thus causing normal operating systems to be impacted. In these cases, temporary substitute equipment may be used. The use of substituted equipment is not considered a change to the facility if the equipment: meets the intended function of the normal operating equipment, is not used for Safety Class (SC) or Safety Significant (SS) systems, and cannot have an impact on SC/SS systems.

Section 5.1 describes the design considerations and criteria for the DWPF.

Section 5.2 describes the building layout and individual process areas for the Vitrification Building (the main process building for the DWPF). The cells and facilities contained within the Vitrification Building are also covered in this section.

Section 5.3 describes the support buildings and structures outside the Vitrification Building, emphasizing radioactive material control.

Section 5.4 describes service and utility systems.

Section 5.5 identifies and describes the sources of radiation within the DWPF facilities and how these sources serve as the basis for the shielding and radiation safety design of the plant.

Section 5.6 lists references in this chapter.

5.1 DESIGN PROVISIONS AND CRITERIA

5.1.1 GENERAL

This section provides a description of the design considerations and criteria applicable to the control of the radiological and hazardous material hazards that exist within the DWPF. The original design basis criteria used for structural design is described. In addition, the provisions for multiple confinement barriers for radiological and chemical hazards, decommissioning, industrial and chemical safety, and human factors engineering are discussed.

5.1.2 STRUCTURAL DESIGN AND CLASSIFICATION

This subsection outlines the original design basis criteria used for structural design. The DWPF Basic Data Report and the DWPF PSAR form the basis for the design and construction of the DWPF (Ref. 1, 2). The Basic Data Report (BDR) describes project objectives and design requirements. It describes functions and requirements of the major structures in order to provide guidance in the design of the facilities. Also, it requires that items, structures, and services are assessed and classified in accordance with the Quality Assurance Assessment Methodology described in Subsection 5.1.2.2. This classification ensures that all items will be properly designed, constructed, installed, and tested. The Detailed Design Instructions-2 (DDI-2) was the design input which bridged from the BDR to the actual design. The BDR is now a historical document and the current design basis criteria are now maintained in the System Design Descriptions (SDD) for DWPF.

The technical specifications provide more detailed information used for the design, construction, and procurement of equipment and structures. Appendix B of Reference 3 provides the technical specification numbers with their descriptions.

5.1.2.1 Approach to Structural Classification

Classification of plant facilities is based on an item-by-item analysis of the various facilities. Each structure, system, and component is evaluated in terms of its importance in protecting the safety of employees and the public and in avoiding an unacceptable loss. Factors considered in this evaluation include:

- The hazardous nature of the material handled in a given facility including the quantity, the physical and chemical form, the potential mobility, and the biological effect of ionizing radiation.
- The specific safety functions performed by the item under consideration during normal and abnormal conditions. These conditions include seismic and other natural phenomena events in addition to operational occurrences.
- The severity of the consequences of failure in terms of radiation dose received by a hypothetical individual located at the site boundary or by a plant employee.
- The protection of the DOE investment in the DWPF.

Based on the criteria above, the structures, systems, and components at the DWPF are classified in three design categories as described below:

Category I - Those structures, systems, and components which, by virtue of management's decision or the safety assessment process, must withstand the effects of Design Basis Earthquake (DBE), Investment Protection Earthquake (IPE), and Design Basis Tornado (DBT) loads.

Category II - Those structures, systems, and components that are not Category I, but whose failure could endanger the safety function of a Category I structure, system, or component. When a structure, system or component is classified as Category II under these conditions, one of the following requirements shall be satisfied:

1: Adequate structural separation must be provided to ensure that the detrimental interaction with the Category I structure, system, or component does not occur; or

2: The Category I structure, system, or component can withstand the loads imposed upon it due to the failure of the Category II structure, system, or component without impacting its safety function; or

3: An analysis shall show that the Category II structure, system, or component can withstand the effects of DBE and DBT loads.

Category III - Any structure, system, or component that is not designated as Category I or Category II belongs in this category and shall be designed in accordance with the provisions of conventional codes. Design for the code earthquake is based on the requirements of Reference 4, using Seismic Zone 2 from this reference.

These design bases are as follows:

1. Design Basis Earthquake (DBE) facilities are those structures, systems, and equipment that are designed to resist an earthquake up to the magnitude of the DBE as described in Chapter 3. In the unlikely event that an earthquake should occur, the DWPF may not be usable as a production facility, but it would continue to confine the radioactive materials to protect the health and safety of the public.
2. Investment Protection Earthquake (IPE) facilities are those structures, systems, and equipment that are designed to resist an earthquake of a smaller magnitude than the DBE as described in Chapter 3. The IPE design criteria were applied as necessary to structures, systems, and equipment to ensure that the facility can be restored to production operation following the repair and/or replacement of damaged Category III equipment. Thus, the investment in a relatively high cost production facility is protected by ensuring that the facility can be restored to productive operations following this smaller earthquake.
3. Design Basis Tornado (DBT) facilities are those structures, systems, and equipment that are designed to resist the DBT. In the unlikely event that a tornado strikes the DWPF, DBT facilities will confine the radioactive materials to protect the health and safety of the public.

4. Standard construction facilities are those structures, systems, and equipment not designed to either DBE, IPE, or DBT criteria. Failure of standard construction facilities will not compromise the safety of offsite individuals.

Each plant structure, system, and component was evaluated against these criteria and classified according to the type of construction required, in accordance with Reference 5.

5.1.2.2 Quality Assurance Classification

The DWPF QA Program that was in place during design and construction was implemented through the Savannah River Plant Quality Assurance Policy and the Savannah River Plant Quality Assurance Plan (Ref. 6, 7). A DWPF Project Quality Assurance Plan was implemented to provide detailed instructions to each major participant in the project for implementation of the Quality Assurance Requirements (Ref. 8).

The degree of application of the project quality assurance program was based upon a series of assessments, culminating in Quality Assurance Action Plans (QAAPs) for components that prevent or mitigate consequences of failures that could cause assessment criteria to be exceeded. These QAAPs outlined actions to be taken during design, construction, and operation. Savannah River Construction QA plans were developed upon QAAP requirements.

The QA assessment process was employed to determine the consequences of failure of items or services. This process was implemented with three engineering procedures (Ref. 9, 10, 11). Items or services were designated Q if the QA assessment determined that the failure of that item or service could result in an event that would exceed the limits of the QA assessment criteria. These items and services were then controlled by additional or special design or QA actions to prevent the failure or mitigate the consequences of failure. For those items and services that were classified as Q, a QAAP was developed to prevent the failure or mitigate the consequences of failure.

5.1.2.3 Structural Design Criteria

The design of the structures at the DWPF was based on the categorization defined in Subsection 5.1.2. The structural design requirements, load definitions, design loads, load combinations, and material requirements for all structures, systems, and components are described in Reference 5. In addition, the design is based on consideration of such factors as the environment, specific conditions, and public safety.

5.1.3 PROTECTION BY MULTIPLE CONFINEMENT BARRIERS

The DWPF vitrification process has been designed to solidify and contain most of the radioactivity from stored High Level Wastes (HLW). Operations to isolate radioactivity are followed by glass melting operations to incorporate the HLW into a borosilicate glass. The radioactive glass is poured into canisters that are upset resistance welded to prevent leakage.

Special design provisions are required to ensure the following:

- Hazardous radioactive and chemical solutions are properly confined and directed during processing operations
- Ventilation air from process operations is properly confined, treated, and released to control the spread of radioactive contamination
- Operating personnel are adequately protected from exposure to hazardous chemicals, excessive radiation, or airborne contamination
- All process streams are properly confined, treated, and handled for release, disposal, or retreatment. These provisions are generally referred to as "confinement."

The total confinement system consists of one or more individual confinement barriers and systems that restrict releases of radioactive material or hazardous materials to the environment or into areas normally occupied by plant personnel.

5.1.3.1 Radioactive Material Releases

The confinement systems and barriers limit releases of radioactive materials to: 1) controlled areas so that individuals are not exposed to concentrations of radioactive materials in excess of the limits specified in 10 CFR 835, and 2) uncontrolled areas so that releases of radioactive materials are as low as reasonably achievable and do not exceed the annual limit prescribed in DOE Order 5400.5. All areas that have the potential for airborne contamination are monitored by Radiation Control Operations (RCO) before personnel entry. A decision is then made as to the level of protection required.

The methods of confinement depend on the mobility, quantity, type, and intensity of the radioactive material and its effect on the ecosystem. The first confinement barriers are commonly the walls of process vessels, piping, and product containers. Additional barriers, as necessary, are provided by ventilation systems, off-gas systems, gloveboxes, process cell walls, or building walls. The additional barriers serve to limit the spread of airborne contamination that could arise from leakage of either gases or liquids from process and storage vessels into cell air spaces and ultimately into other areas. Barriers are also used to prevent the spread of contamination via leakage of contaminated liquids and solids.

5.1.3.2 Hazardous Chemical Releases

The confinement systems and barriers limit releases of mercury and other hazardous materials to: 1) restricted areas such that individuals are not exposed to chemicals in excess of mandatory industrial hygiene standards of DOE Order 5480.8A, and guidelines given in DOE Order 5480.10, and to 2) unrestricted areas so that releases of hazardous chemicals are as low as reasonably achievable and do not exceed the annual limit specified by the SCDHEC release permit.

5.1.3.3 Confinement Barriers and Systems

Confinement barriers and systems are selected in accordance with proven practices.

1. To limit the spread of airborne radioactivity, the facility is separated by confinement barriers into areas of zones of various levels of contamination.
2. The building ventilation and process off-gas systems control the spread of airborne contamination through openings in barriers by regulating the direction of air or gas flow between these zones so that gas leakage is successively from zones of low potential to zones of higher potential for contamination.
3. The capacity of the ventilation system is adequate (in relation to confinement system requirements) to ensure that the velocity of gas flowing through any barrier opening is sufficient to prevent the backflow of airborne contaminants through such openings; air flow patterns must not be disrupted by winds, movement of equipment or personnel, or temporary opening of passageways through confinement barriers.
4. Cooling water that could become contaminated by leakage of process solutions through defects in heat exchanger components is contained in closed secondary circuits with independent primary heat transfer circuit. These are monitored for radioactivity.
5. Steam, used where it could become contaminated, is in a closed loop system. The condensate is monitored and reused as feed to the process steam generator; contaminated condensate is purged and flushed to the recycle collection tank.
6. Penetrations through confinement barriers that could provide potential pathways for release of radioactivity to the environment have means for isolating the penetration, such as airlocks at entrances to zones. Penetrations for wiring, piping, and instrumentation are sealed to prevent backflow of contamination to normally occupied areas.
7. Two types of confinement barriers are used in the facility. "Total barriers" are those fabricated of material that prevents penetration of all confined material without regard to the physical or chemical nature of the material. "Selective barriers" are mass transfer devices or filters that are employed to remove selected chemicals or particulate matter from a process or ventilation stream while allowing the bulk amount of the stream to pass through.
8. Barriers are designed to withstand loadings due to pressure differentials imposed by the process off-gas and building ventilation systems as well as pressure differentials caused by natural phenomena.
9. To monitor the integrity of ventilation zones, pressure monitors are provided to indicate pressure differentials between confinement zones. To monitor for liquid confinement, leakage is detected by a liquid high level alarm in a designated leakage collection sump. Continuous Air Monitors (CAMs) or air samplers are used to indicate loss of function of a barrier, which could release radioactivity from a designated confinement area into an occupied area.
10. Confinement systems are constructed of nonflammable materials except where this is not possible because of special functional requirements.

11. Materials of construction are resistant to the corrosive effect of process and decontamination fluids at the temperatures and pressures encountered.
12. Back-up power is provided to those confinement barriers and systems where loss of confinement capability could result from loss of primary electrical service.
13. Standby fans are provided to automatically take over the function of any essential fan that may become inoperative.
14. The confinement barriers are designed to maintain their functional integrity under the hypothesized design basis accidents where required.
15. The confinement systems and their components in the Vitrification Building are designed to allow maintenance to the system during operation. The Low Point Pump Pit and 512-S do not provide maintenance capability during processing.
16. Confinement of hazardous material in the vitrification building is generally accomplished using the confinement barriers and ventilation systems installed to confine radioactive materials within the process cell and to limit exposures to personnel in the operating areas of the building. The vitrification building confinement systems are described in Subsections 5.2.2.2 and 5.4.1 and in Chapter 7.
17. For the equipment housed in the chemical and industrial waste treatment building, confinement is provided by the tanks and vessels in the system. Subsections 7.3.1.2 and 7.3.2.1 discuss gaseous effluents and liquid wastes for this facility.
18. Confinement for cold chemical feeds is provided by the tanks and vessels. Additional confinement features include such things as spill dikes around all tanks and high level alarms with interlocks to prevent overfilling. The spill dikes are constructed of concrete and coated with a sealant to prevent migration of the hazardous chemical(s) into the surrounding soil. The cold chemical system and its confinement features are described in Subsection 5.4.13.

5.1.3.4 Ventilation Systems

The ventilation systems are an essential part of confinement of the radioactivity and hazardous vapors that are byproducts of the process. The ventilation systems are provided with the following features:

1. Supply fans are normally interlocked with exhaust air plenum pressure sensors to prevent supply fan operation unless exhaust fans are running.
2. Airlocks are provided where frequent entry between different contamination zones is necessary and where flow must be maintained in one direction.
3. The ventilation system is designed to maintain a pressure differential sufficient to maintain air velocity through designated process air openings to prevent reverse flow of contaminated air.
4. The final HEPA filter or sand filter in an effluent filter system design is based on conservative assumptions for filtration factors for the particles.

5. Installed standby fans and isolation dampers are provided to take over the function of a fan that may become inoperative. Alarms or alerts are provided in continuously occupied areas to indicate malfunction of the ventilation system. Standby power is supplied to Zone 1 exhaust fans automatically.
6. In case of stack blockage, a port on the duct segment leading from the fan house to the stack can be opened to allow the already filtered exhaust air to be discharged to the atmosphere near grade level.
7. Flow capacity of each vent system is based on consideration of heat load requirements and/or air changes per hour.

5.1.4 DECOMMISSIONING

The general design criteria for DOE facilities require that design features be considered which will facilitate decommissioning. Consequently, a set of design criteria for the decommissioning of the DWPF was established (Ref. 1). These design criteria, which are listed below, were based on the following assumptions:

- Dismantlement is the ultimate objective of the DWPF decommissioning effort;
- Techniques and methods of decontamination and decommissioning will probably change during the lifetime of the DWPF;
- The intent of the regulations is to anticipate the most likely method to accomplish decommissioning;
- The DWPF will be one of the last facilities at SRS to be decommissioned; and
- The criteria selected to assist in decommissioning will not represent a significant increase in cost.

Given these assumptions, 17 design criteria for decommissioning the DWPF were established. Criteria 1 through 6, in addition to assisting decommissioning, are required for process operation and were therefore included in the general design criteria for the process building. Criteria 7 through 17 were developed specifically for decommissioning and were to be applied to the extent that no significant additional costs would be incurred as a result of their adoption.

1. <u>Maintenance</u>. Provide the capability to remotely introduce, loosen, take apart, disconnect, locate, relocate, and remove equipment in the process cell.
2. <u>Compartmentalization of Process Functions</u>. Where practical, process functions should be divided into different compartments.
3. <u>Access to Process Equipment</u>. Provide ready remote access to contaminated process equipment. Provide removable covers for the process cells.
4. <u>Cell Sumps and Sump Pumps</u>. Provide a sump and sump pump for each decon cell and process cell for removal of liquid. In any cell where liquids are not routinely handled during normal operation, include a sump with provision for later addition of the sump pump as a minimum.

5. Protective Coatings. Protective coatings should be applied to concrete surfaces subject to chemical or radioactive spills. If stainless steel linings are not used, a protective coating recommended to resist deterioration caused by radiation and process and decontamination chemicals should be applied.

6. Openings, Wall Penetrations, and Service Piping. Keep the number of wall penetrations to a minimum.

7. Provision for Chemical Decontamination. Provide capability of modifying piping and services to allow chemical decontamination of canyon surfaces. Provide spray rings or decontamination features in the decontamination cells.

8. Liquid Waste Disposal. Provide a means to transfer liquid waste from sump collection tanks and cell washdown to the Waste Tank Farm.

9. Isolation of Sections of Ventilation System. Consider providing a method of ventilation control that will permit air flow from selected process cell sections to be selectively reduced or eliminated at the exhaust entrance to the air tunnel. This capability is not required during normal operations, but provision for installation during decommissioning is desirable.

10. Control Room Location. If feasible, the control room should be located so that controls for the continued operation of the Weld Test Cell will be available during dismantlement.

11. Electrical Substations. If practical, the location of substations should be chosen to facilitate the continued operation of the Weld Test Cell, Canister Decon Cell, Remote Equipment Decontamination Cell, and Contact Decontamination Maintenance Cell.

12. Capability for Mechanical Decontamination. Following chemical decontamination of canyon surfaces, it may be necessary to remove residual contamination by grinding or other methods. Design should facilitate the spalling of the concrete surface.

13. Coating of Exhaust Tunnels. The exhaust air tunnels from the process cells should have a dustproof coating.

14. Access to Sand Filter. Provide air lock access to the top of the sand filter to permit entry for sand removal and decontamination.

15. Secondary Filtration at Sand Filter. Consider provisions for passing air from the sand filter through HEPA filters before discharge to the stack during decommissioning. This can be accomplished by providing any knockout plugs, etc., that might be required to divert the sand filter exhaust to the HEPA filtration system. As an alternative, reserve sufficient space between the sand filter and the stack to install a HEPA system during decommissioning.

16. Air Flow Patterns. Air flow patterns should be from clean areas to radiological areas to process cells.

17. Volume Reduction of Waste. Volume reduction, treating, and packaging of solid waste is a desirable feature. This capability is not required during normal operations,

but provisions for installation during decommissioning should be considered, at least in a limited scope, during final design.

As discussed above, Criteria 7 through 17 were to be considered for implementation based on economics. Consequently, the design changes associated with each criterion were evaluated as part of the design evolution process, and were incorporated when there was no significant cost increase. A discussion of the decommissioning program is provided in Section 10.11.

5.1.5 INDUSTRIAL AND CHEMICAL SAFETY

5.1.5.1 Overpressurization

Overpressurization of plant equipment is prevented by one or more of the following:

1. Venting of all process vessels to an appropriate off-gas system.
2. Providing pressure alarms where appropriate.
3. Providing pressure relief devices.
4. Overflow line to the process cell or drain system.

5.1.5.2 Corrosion

Corrosion allowances are included, where appropriate, in the design of all process vessels and equipment to ensure adequate performance of the equipment. These allowances are shown on the vessel data sheets and vendor documentation.

5.1.5.3 Chemicals

Design of the process equipment considers the nature of the chemical service required; e.g., sodium hydroxide, monosodium titanate, and formic acid. Provision is incorporated in the design for the safe handling of a chemical.

5.1.5.4 Industrial and Chemical Criteria

Industrial hygiene criteria applicable to DWPF design included the following:

- DOE Order 5480.8A, Environmental Protection, Safety and Health Protection Standards
- DOE Order 5480.10, Contractor Industrial Hygiene Program
- Manual 4Q, SRS Industrial Hygiene (Ref. 12)
- American Council of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices
- OSHA, 29 CFR 1910.1000 Subpart Z, Toxic and Hazardous Substances

Other industrial and chemical design criteria were established as part of the design process. As the DWPF design evolved and design concepts were developed, the appropriate safety criteria documents were identified. Typical design codes and standards identified and used include:

- NFPA 30, Flammable and Combustible Liquids Code
- OSHA, 29 CFR 1910.106, Flammable and Combustible Liquids
- OSHA, 29 CFR 1910.95, Occupational Noise Exposure
- OSHA, 29 CFR 1910.219, Mechanical Power Transmission Apparatus
- NFPA 70, National Electric Code

5.1.5.5 Cold Chemical Systems

Special requirements were included in the design for cold chemical systems. These were based on the following criteria:

- Tanks in 512-S shall be vented to the atmosphere through gooseneck vents.
- Tank drains and overflow lines shall discharge to a drain system. Separate drain systems shall be provided for nitric acid waste, organic acid waste, and caustic waste to prevent mixing of incompatible chemicals.
- Tanks with charging chutes for adding dry chemicals shall be connected to a vent system to limit dusting when dusting is a concern, as determined by the Industrial Hygiene Program.
- Dikes and sumps shall be provided to contain tank leakage and spillage.
- Safety showers and eyewash stations shall be provided and located in accordance with OSHA standards.

5.1.5.6 Industrial and Cold Chemical Facilities

The criteria listed in Subsections 5.1.5.4 and 5.1.5.5 are primarily applicable to the following DWPF buildings:

- 221-S Vitrification Building
- 210-S Service Building
- 422-S Cold Chemical Storage/Bulk Frit Storage Building
- 980-S Water and Chemical Waste Treatment Building, Neutralized Fire Water Storage Tank, and Domestic Water Storage Building
- 981-S Cooling Tower (Chemical Treatment Building Portion)
- 511-S Low Point Pump Pit
- 512-S

- 512-6S Laboratory
- 512-7S Cold Chemical Storage Area

5.1.6 HUMAN FACTORS ENGINEERING

The management process for Human Factors issues consists of the following two elements: 1), an approach to Human Factors Engineering (HFE) that focuses on designing Systems, Structures, and Components (SSCs) in accordance with the capabilities, limitations, and needs of humans; and 2), the use of quantifiable Human Reliability analysis data in determining the accident event frequencies that support the DWPF risk analysis (Ref. 34). The safety basis for the vitrification process utilizes a graded approach to full compliance with DOE Order requirements.

HFE considerations are applied to the design of safety class and safety significant SSCs as described in Reference 13. Design features are provided to assure that key safety system parameters are monitored and that indications are functional during post-accident conditions. In addition, design features are installed to allow personnel a means to actuate safety equipment in the event the equipment fails to function.

The Human Reliability Analysis element of Human Factors is fully applicable to the facility and has been a part of the DWPF safety analysis process from historical conception of the vitrification process to the present hazard and accident analysis as presented in Chapter 9.

5.1.6.1 Requirements

The requirements for delineation and implementation of the HFE considerations for new projects or major modifications to the existing DWPF safety basis within DWPF are established by the SRS Engineering Standards Manual (Ref. 40) and Procedure Manual E7 (Ref. 14).

5.1.6.2 Human Factors Engineering Program

Requirements for the consideration of HFE are defined and implemented by the Conduct of Engineering and Technical Support procedures (Ref. 14). The Design Authority (DA) utilizes the process to ensure achievement of project missions and goals, preferred system configuration, and preferred technology.

The design of DWPF was initiated in the early 1980s before human factors standards relative to facility safety became a prominent issue. During the early phases of DWPF design and construction, what are now known as Human Factors (HF) considerations were existent in other design input requirements. Many of the current HF criteria (e.g., human dimension considerations, environmental considerations, normal and emergency lighting, noise, etc.) were contained within other national consensus standards such as OSHA and NFPA. These criteria were included in the earliest phases of the conceptual design process.

Following the issuance of DOE Order 6430.1A in the late 1980's, prudent cost/benefit decisions were necessary to determine what extent the Order was appropriate for the pre-existing design at DWPF and to what extent a graded application of the requirements should be utilized. The initial

efforts to evaluate HFE considerations consisted of a study and report documenting the level of compliance with DOE 6430.1A (Chapter 1). Since that time safety SSCs have been identified for the DWPF and HFE considerations have been applied as described in Reference 13.

The Actinide Removal Process (ARP) 512-S Facility Design Description specifies compliance with Human Factors Engineering requirements in 512-S (Ref. 41).

5.1.6.3 Identification of Human-Machine Interfaces

The earliest design activities associated with DWPF did not take into full consideration the identification of Human Factors concepts as would occur with the safety analysis process currently in place at the SRS. DWPF Program Management, recognizing the importance of HF considerations and the potential historical inadequacies regarding their application, chartered the Control Room Action Committee (CRAC) to act as a focal point for issues of concern for Operations. Human Factors considerations were considered appropriate and applicable to the Central Control Room (CCR) and the adjoining Supervisors Control Room (SCR) in order to assure operational reliability and that the facility will meet production objectives. The charter for the CRAC identified specific areas for which the committee was directed to focus. Those areas included Human Factors Considerations, Operator Work Load, Alarm Management, and Operational Efficiency. As a result of CRAC recommendations DWPF management took a proactive posture toward ensuring compliance with HFE criteria through the sanctioning of two independent studies during January and June of 1992 that addressed human-machine interfaces in the DWPF CCR and SCR.

The first of the two studies, known as the Control Room Design Review (CRDR), was initiated to ensure that the CCR and various aspects of the SCR meets HFE guidelines and principles (Ref. 16). Candidate HF design deficiencies were identified and entered into a database for tracking and potential resolution. Recommendations were provided within the report for correction of the identified issues. The second of the two studies consisted of a review and evaluation by a team, known as the Control System Expert Panel (CSEP), who independently reviewed and generally confirmed the candidate deficiencies identified during the CRDR (Ref. 17). The CSEP report also recommended corrective actions.

Candidate HF discrepancies identified during the studies discussed above were grouped into the following HF considerations: Control Room Workspace and Environment, Controls, and Alarms Management. Resolution of Alarms Management System discrepancies is currently considered to be the most essential element of HFE with regards to personnel safety, operational reliability and production objectives. Human-machine interfaces are an integral part of facility safety for preventive actions (e.g., surveillance and maintenance activities during normal operations) and for mitigative actions during abnormal and emergency operations. The interfaces during normal operations are identified in the TSR and in Chapter 11 as surveillance requirements. The post-accident operator actions requiring human-machine interfaces are identified in Chapters 4 and 9.

5.1.6.4 Optimization of Human-Machine Interfaces

Human-machine interfaces for preventive actions (e.g., surveillance and maintenance activities during normal operations) are required by the TSRs as Surveillance Requirements. These interfaces are performed as part of operator rounds for TSR implementation. These interfaces are also performed under a Conduct of Operations program which is discussed in Section 10.3. The Conduct of Operations program requirements apply to the programs and functions of SRS operations that may have an impact on the safety of the public and site personnel. This program is the minimum acceptable level of performance expected of operations and support personnel which may affect safety. It also requires a commitment to continuously improve operations by using total quality principles. The Conduct of Operations program addresses the following elements:

- Furnished instrumentation, provisions for communication and operational aids to support timely, reliable performance for safety functions.
- Layout and design of controls and instrumentation as well as provisions for labeling.
- Work environments, including physical access, need for personal protection equipment, noise levels, distractions, etc.
- Staffing considerations (e.g., minimum staffing levels, allocation of control functions, overtime restrictions, facility status turnover between shifts, procedures, training, etc.).

5.2 VITRIFICATION BUILDING

The Vitrification Building is a multilevel reinforced concrete structure designed as a Category I Facility in order to provide maximum resistance. It houses the radiological process operations in shielded confinement cells. The balance of the building is standard construction and includes a manipulator repair shop, a radiological machine shop, a railroad airlock, a Shielded Canister Transporter (SCT) maintenance and decontamination area, and a filter room.

The seismic inputs for building design are specified in Chapter 3. The anticipated foundation loading for the Vitrification Building is less than the bearing capacity of the foundation soil as discussed in Chapter 3. The building is designed so that allowable stresses due to foundation deformations are not exceeded.

Future additions to the Vitrification Building are not anticipated; therefore, structural provisions for additions are not required.

5.2.1 STRUCTURAL CRITERIA

The Vitrification Building is a Category I facility as defined in Section 5.1. Design criteria for radiation shielding are provided in Section 5.5. The remainder of the building is of standard construction (Category III) as defined in Section 5.1.

5.2.2 BUILDING LAYOUT

5.2.2.1 Building Descriptions

STRUCTURAL DESCRIPTION

The foundation of the maximum resistance structure (the Vitrification Building, which is Category I) is a reinforced concrete base mat. The top of the base mat is at or below grade (which is about 30 ft above the water table). The superstructure is a reinforced concrete structure built to maximize its effectiveness for confining any radioactive materials that might be released from the process system.

Segmented process drainage systems are provided where necessary to collect spillage, floor washdown, and rinse water in those areas of the building where such liquids can become contaminated. These liquids, if contaminated, are routed to the recycle collection tank.

A radiation shield door isolates the main process cell area from the crane maintenance area. Where required, the reinforced concrete structures also act as shield walls.

MAJOR BUILDING AREAS

The main process cells include the following:

- The Salt Process Cell (SPC)

- The Chemical Process Cell (CPC)
- The Glass Melt Cell (MC)
- The Backup Off-gas Cell (BUOGC)
- The Canister Decontamination Cell (CDC)
- The Weld Test Cell (WTC)
- The Remote Equipment Decontamination Cell (REDC)
- The Contact Decontamination and Maintenance Cell (CDMC)

These cells, except for the WTC, are located in the Remote Process Cell (RPC) and are serviced by the main process cell crane.

New equipment to be installed in the RPC, or failed equipment to be removed from the RPC, is normally moved in or out of the Vitrification Building by way of the railroad well at the south end of the building.

All operations and maintenance on facilities located in the SPC, CPC, MC, BUOGC, CDC, and REDC are done remotely. Shielded viewing windows are provided in the following main process cells (REDC, CDMC, MC, CDC and WTC) as well as in the following areas (CDC Smear Test Station [CDCSTS], Mercury Cells, Analytical Cells, Sample Cells, and the Crane Maintenance Area [CMA]) for observing operations.

Air lock separation is provided between the remote process cell and the exterior of the Vitrification Building. This air lock can accommodate a full size rail flatcar carrying the largest piece of process equipment. Rails are recessed in the airlock floor so that trucks or tractor/trailer rigs can also be used to deliver or remove equipment or components from the building.

Air lock doors for the main process cells are administratively controlled. There are no interlocks or controls to prevent both doors from being open at the same time.

Each of the individual main process cells (excluding the BUOGC), the railroad well, and each transfer tunnel (excluding the MC/CDC tunnel) are equipped with a sump and sloped floors to facilitate drainage into the sump. Decontamination washdown solutions used in the cell and any spilled materials are collected in the sumps. Materials from sumps are pumped to the Decontamination Waste Treatment Tank (DWTT) or to the Recycle Collection Tank (RCT), neutralized, and transferred to the tank farm via the RCT. Drains from the crane maintenance floor sump are routed to the DWTT via the hot decon waste header.

The transfer tunnel at the west side of the WTC is the loadout point where waste canisters are picked up by the SCT for transfer to one of the Glass Waste Storage Buildings or unloaded from the SCT if a canister needs to be returned to the Vitrification Building.

The SPC and CPC are separated by a concrete wall that can be removed in sections.

PERSONNEL MOVEMENT AND ACCESS

The main personnel entrance into the RBA portion of the Vitrification Building is via a building stairwell from the Service Building 210-S adjoining the Vitrification Building.

Access to clean areas on the second level of the Vitrification Building is through a building stairwell from a clean area in the Service Building.

Stairwells, controlled as required, are located throughout the building to provide access for each level. All stairwells have emergency exits at grade level.

A freight-type elevator is provided. The elevator meets ANSI A17.1 requirements (Ref. 18). The elevator is accessible and protected with hoistway doors and car gates from either end, as required by the loading dock and interior floor layouts at different elevations.

EQUIPMENT AND FACILITY LOCATIONS

The east personnel corridor on the first level contains the decon frit slurry feed tank and pumps, portions of the melter closed loop cooling water system, and REDC and CDMC decontamination chemical feed tanks. Empty canisters from the Service Building enter the Vitrification Building at this level through an east side airlock via a monorail hoist. The first level west corridor has HEPA filters for the analytical lab hoods, the exhausters for the HP vacuum air sampling system, the shop area, and the closed loop steam generator.

A mezzanine level above the west first level floor is occupied by the laboratory facilities and the process closed loop chilled water chillers and pumps. HEPA filters and exhaust fans for the WTC are on the northeast mezzanine, and the north mezzanine contains the welder power packs. The first level and portions of the mezzanine are RBAs.

The second level east corridor is occupied by the melter power control center, electrical switchgear, MCCs, Field Operation Station (FOS) 1 for the distributed control system, plant and instrument air compressors, emergency breathing air bottles and the Backup Control Room. The second level west corridor contains electrical switchgear, MCCs, FOS 2 and FOS 27.

The third level contains service piping and electrical services for RPC equipment. Shops, airlocks, a process closed loop cooling water system, the crane maintenance area, and cold chemical feed tanks are also located on this level.

Safety showers and eyewash stations are provided at all locations where material handling can impose a hazard to personnel. The emergency showers and eyewash stations are connected to the domestic water system. Eyewash stations and safety showers drain to floor drains.

PROCESS CELL FEATURES

The vitrification process is conducted in Building 221-S in a highly radioactive environment behind concrete shielding walls. The remotely operated Main Process Cell (MPC) crane travels over the cells within the Vitrification Building to install or remove in-cell equipment as required

to ensure the operation of the vitrification process. The crane is designed to operate on runway rails and is retrievable to the Crane Maintenance Area (CMA) in the event of an investment protection earthquake.

The vertical lift Crane Maintenance Shield Door (CMSD) between the CMA and RPC provides radiation shielding for personnel working in the CMA. The door is raised into a penthouse on the roof to allow the crane to be brought into the crane maintenance area.

Removable ventilation covers are provided over the salt process cell, the chemical process cell, the melter cell, the backup off-gas cell, the canister decontamination cell, and the remote equipment decontamination cell. Spacing of the ventilation covers provides a means of controlling air flow as the air flows through slots between the covers.

Concrete shielding covers with stepped joints are provided over the contact decontamination and maintenance cell and over the railroad well.

In-cell spaces that have shielded viewing windows and /or cameras are equipped with high intensity lighting. These in-cell lights (lamps and fixtures) are designed and positioned to be replaced remotely.

SHOPS

The Vitrification Building provides space for a variety of maintenance and repair shops. A description is given in Subsection 5.2.3.

COMMUNICATIONS, LIGHTING, AND ELECTRICAL SYSTEMS

A public address system and telephone services are provided for the Vitrification Building.

Lighting levels are in accordance with the standards of the Illumination Engineering Society and Considerations of Energy Conservation (Ref. 19).

Selected building lighting is on standby power. Secondary lighting is provided by battery-operated units located at aisles, corridors, and stairs leading toward building exits.

Electric power is fed to secondary substations at 13.8 kV. The secondary substations transform the voltage to 480 V which feeds MCCs and various loads. MCCs feed many different electrical loads including distribution transformers and panels which distribute power at various voltage levels. Uninterruptible Power Supplies (UPS) are provided for vital instrumentation and control. Structural steel and reinforcing steel in the Vitrification Building are electrically grounded. Grounding is in accordance with the Occupational Safety and Health Administration (OSHA) requirements (Ref. 20).

FIRE PROTECTION

Subsection 5.4.10 gives a description of the fire protection system.

5.2.2.2 Confinement Features

The design of the Vitrification Building incorporates multiple confinement levels to minimize releases of radioactivity to the environment and to minimize transport of radioactive contaminants within the facility.

The primary confinement for the radioactive material at the DWPF consists of the process vessels and piping, process vent systems, and glass canisters. The DWPF processes take place in the closed vessels located in the Remote Process Cells as described in Subsection 5.2.3. The DWPF chemical process tanks produce gaseous byproducts that contain radioactive material. The process vent facilities collect and treat these byproducts as described in Subsection 5.2.3.6. The vitrification process takes place in the melter and also produces radioactive gaseous byproducts. The melter off-gas treatment facilities collect and treat these byproducts as described in Subsection 5.2.3.4. After treatment, all of the process gases are transferred to the Zone 1 HVAC exhaust for further filtration by the sand filter before being released to the stack.

A second level of confinement for the radioactivity in the process cells consists of the canyon structure and the Zone 1 ventilation system. The Zone 1 ventilation system is described in Subsection 5.4.1. The system is designed to keep these areas at a negative pressure relative to the adjoining corridors in order to ensure that any airflow is into the Zone 1 areas. Within Zone 1, airflow is from areas with relatively low contamination to areas with higher levels of contamination. The Zone 1 HVAC system exhausts through a highly efficient sand filter that removes most of the particulate radioactivity before being released to the stack.

RBA corridors surround the portions of the canyon structure that contain openings. These corridors are served by the Zone 2 ventilation system, which is described in Subsection 5.4.1. Although radioactive contamination is not expected in the RBA, it is possible that contamination could be present under abnormal or upset conditions. The RBA and the Zone 2 ventilation system therefore serve to confine any airborne radioactive material that could potentially escape from the Zone 1 areas. The Zone 2 ventilation system exhausts through HEPA filters to reduce the amount of radioactivity released to the environment.

The following additional confinement features have also been incorporated in the Vitrification Building design:

- Personnel and equipment move from one ventilation zone to another through airlocks to minimize air exchange between zones.
- Penetrations for wiring, piping, and instrumentation that could provide a potential pathway for the release of radioactivity are sealed to prevent releases to normally occupied areas or to the environment.
- A segregated process drainage system is provided to collect spills, floor washdown, rinse water from areas, and non-radioactive lab waste.
- Monitoring of airborne radioactivity levels in the RBA is provided to warn of potential contamination or loss of confinement.

5.2.3 INDIVIDUAL PROCESS DESCRIPTIONS

5.2.3.1 Salt Process Cell

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

FUNCTION

Process feed preparation facilities in the SPC provide equipment to supply MST/Sludge Solids. MST/Sludge Solids may be added from the Precipitate Reactor Feed Tank (PRFT) to the SRAT in the CPC.

COMPONENTS

Some process feed preparation facilities are located in the SPC, and they are remotely operated and shielded to reduce radiation exposure to personnel to acceptable levels. The feed facilities include Precipitate Reactor Feed Tank (PRFT). The PRFT is a vertical cylindrical tank with a flat bottom and dished top. The bottom of the tank is sloped to a sump for mercury collection. The PRFT has a heating coil, cooling coil, agitator, and sample and feed pumps. It is purged with nitrogen/air from CPC purge systems described in Section 5.2.3.2.

Additional assurance features included in the design of the feed facilities in the salt process cell include:

- Tank nozzles are located above normal liquid levels.
- The PRFT is vented to an exhaust system which, in turn, discharges to the Zone 1 exhaust tunnel.
- Cooling coils are designed to maintain a positive pressure relative to the radioactive side.
- The cell floors are sloped to sumps with dip tubes for level indication.

5.2.3.2 Chemical Process Cell

FUNCTION

Process feed preparation facilities in the CPC provide equipment to supply slurry to the glass melter. Sludge is pumped from the LPPP to the SRAT as required. If necessary, the SRAT level will be reduced by boiling and MST/Sludge Solids may be added from the Precipitate Reactor Feed Tank (PRFT) during the boiling. SRAT contents are analyzed and Formic and Nitric acids are added. The SRAT contents are boiled and Strip Effluent (SE) may be added from the Strip Effluent Feed Tank (SEFT) during the boiling. Also during boiling, elemental mercury, formed by reduction of mercury oxides, is steam stripped and collected in a decanting/wash tank. Mercury is periodically removed from the wash tank to the mercury purification cell. The SRAT contents are pumped to a mixing tank where frit is added to form a sludge/frit slurry. The slurry

mixture is then transferred to a feed tank from which it is fed into the melter at a controlled rate. This process is described in additional detail in Chapter 6.

COMPONENTS

Most process feed preparation facilities are located in the chemical process cell, and they are remotely operated and shielded to reduce radiation exposure to personnel to acceptable levels. The feed facilities include:

- The Sludge Receipt and Adjustment Tank (SRAT) is a vertical cylindrical tank. Equipment is provided for chemical additions and mixing, heating, and cooling the slurry. Heating and cooling are provided through closed-loop systems. The bottom of the tank is sloped to a sump for mercury collection.
- The SRAT condenser, located on top of the SRAT, uses process cooling water to condense process vapor. The provision is made to reflux condensed liquids via the Mercury Water Wash Tank (MWWT) or drain to the SMECT. Mercury is steam stripped and collected in the MWWT.
- The SRAT Ammonia Scrubber may be utilized to remove ammonia vapor from the SRAT Condenser vent-gas stream by recirculating SMECT condensate as the scrubbing medium. The scrubber is a packed column mounted above the SRAT and is located at the exit of the SRAT Condenser. Provisions are made for flushing the scrubber.
- The SRAT and SME steam and cooling coil assemblies adjust the temperature of the slurry mixture. Each tank agitator fits inside the coils and can be removed independent of the coil assembly.
- Sample pumps transfer liquids/slurries to a sample cell where samples are collected.
- The Mercury Pump, which can be installed in several process tanks, is a pressure chamber with high pressure water as the driving force, and propels mercury to its destination.
- The Slurry Mix Evaporator (SME) is a vertical cylindrical tank. Equipment is provided to add frit and chemicals and to mix, heat, and cool the mixture. The bottom of the tank is sloped to a sump for mercury collection.
- The SME condenser condenses process vapors during evaporation of the slurry mixture. The condenser is cooled using the closed-loop process cooling water system. Condensate is drained to the SMECT.
- The SME Ammonia Scrubber is located at the exit of the SME Condenser, and the RCT/MFT Ammonia Scrubber is located at the RCT/MFT ventline. These scrubbers differ from the SRAT Ammonia Scrubber only in their sizes. In addition, the SME Ammonia Scrubber is not supplied with scrubber solution.
- The SME Condensate Tank (SMECT) is a vertical cylindrical tank. The SMECT collects condensate drained from the SME condenser and/or SRAT condenser (by way of the MWWT). The scrubber solution pump delivers the condensate to the

ammonia scrubbers (except for the SME scrubber where scrub solution is no longer supplied) when the scrubbers are utilized. The SMECT is provided with an air sparge, cooling coil, and nitric acid addition capability. The tank bottom is sloped to a sump for mercury collection.

- The Melter Feed Tank (MFT) is a vertical cylindrical tank. Two pumps on the tank circulate the contents through two recirculating loops. A small stream is bled from one of the feed loops through the feed tube to feed the melter. Equipment is provided for chemical addition and mixing the slurry. The bottom of the tank is sloped to a sump for mercury collection.
- Mercury Water Wash Tank (MWWT) is mounted on the SMECT. Mercury stripped out of the SRAT is collected in the MWWT. Elemental Mercury settles to the bottom of the MWWT and is transferred to the mercury purification cell to be decontaminated and then recovered.
- The SEFT is a vertical cylindrical tank. Equipment is provided for chemical addition, mixing and cooling the SE. The bottom of the tank is sloped to a sump for mercury collection. The SEFT receives SE from the H-Area Strip Effluent Hold Tank (SEHT) via an interarea transfer line, which includes jumpers in the LPPP-RPT and PPT Cells.
- The CDC-SME Isolation Pot is located on top of the SEFT. The CDC transfer pumps transfer spent frit to the SME through the CDC-SME isolation pot.

The CPC Primary Purge System consists of air compressors, an air receiver tank, air dryers, a liquid nitrogen storage tank (near 422-S), ambient vaporizers (near 422-S), and various pressure and flow control valves. The CPC Primary Purge System provides an air/nitrogen purge to the PRFT (in the SPC), SEFT, SRAT, SME, SMECT, MFT, RCT, and DWTT and is backed up by CPC Safety Grade Nitrogen Purge System. The purge system provides the purge through the vessels to the PVVH, which exhausts into the Zone 1 exhaust tunnel.

The CPC Safety Grade Nitrogen Purge System, consisting of two ambient vaporizers and interconnected liquid nitrogen storage tanks (located north of 221-S), provides a nitrogen source that initiates automatically in the event of low purge header pressure. This system also consists of redundant pressure regulators on nitrogen tie-ins and double check valves. The purge system provides a purge through a manual purge flow valve (needle or globe valve) to the PRFT, SEFT, SRAT, SME, SMECT, RCT, DWTT, and MFT to the PVVH, which exhausts into the Zone 1 exhaust tunnel. The lines to the PRFT, SEFT, SRAT, SME, SMECT, RCT, DWTT, and MFT also have pressure control valves which maintain the upstream pressure required for the flow elements.

The PRFT, SEFT, SRAT, SME, SMECT, MFT, RCT, and DWTT flow instrumentation and the nitrogen supply inventory instrumentation provide post accident monitoring capabilities. The CPC Safety Grade Nitrogen Purge System does not rely upon electrical power.

Additional features for the process feed preparation facilities in the chemical process cell include:

- Tank nozzles are above the normal operating liquid levels.
- Tanks are vented to the process vessel ventilation system which, in turn, discharges to the Zone 1 exhaust tunnel.
- Seal pots, valves, and other systems are provided to prevent vapor or liquid backup into nonradioactive lines.
- Receiving tanks can interlock feed pumps to avoid overfilling.
- Steam and cooling coils are designed to maintain a positive pressure relative to the radioactive side.
- The cell floors are sloped to sumps with dip tubes for level indication.
- Gas chromatographs are provided for SRAT and SME vent gas. Interlocks are provided to stop SRAT and/or SME processing at established levels.

5.2.3.3 Melt Cell

FUNCTION

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

The melter is operated with a crust (cold cap) composed of waste calcine and frit that covers most of the melt surface. The feed slurry is introduced onto the top of the cold cap. Water from the slurry is evaporated and drawn into the off-gas system. The glass melt beneath the cold cap is at molten glass temperature, which causes the cold cap to melt from the bottom and form a borosilicate glass-waste matrix.

The molten glass flows through the melter throat, up the riser and down the pour spout into a stainless steel canister connected to the melter by a bellows. This flow path is surrounded by a ceramic assembly, which keeps the molten glass at an elevated temperature until it is poured into the canister. The canister is fabricated of 304L stainless steel with a concentric nozzle at the top where the pour spout interfaces with the canister.

COMPONENTS

The melter design lifetime is conservatively estimated to be 2 yr. This is based on the calculated life of the refractory in the melter shell. Any melter component that has an anticipated lifetime of less than 2 yr. is designed for remote replacement by either overhead crane, in-cell crane, or manipulator.

The melter facilities include the following:

Melter Shell

Melter construction includes a steel outer vessel with an inner refractory liner for primary glass containment. The melter vessel rests on a stainless steel melter support and lifting frame that locates the melter vessel and its accessories by means of trunnions that fit into floor guides.

The melter is insulated to minimize conductive heat transfer from the hot glass to the outer shell. Because refractories have joints and/or cracks, containment is ensured because the thermal gradient will freeze the glass within the refractory joints. The temperature at which glass is suitably frozen is called its softening point. The walls have a cold side temperature below the softening point to ensure that no glass will leak through. If glass should eventually leak through the glass contact refractory in the floor or walls of the melter due to cracking or erosion, the cold outer shell will prevent leakage from the melter. The glass contact refractory is separated from the stainless steel shell of the vessel by an approximate 3/4-in layer of moldable ceramic fiber insulation, which provides thermal insulation and allows for thermal expansion of the glass contact refractory. This function is performed in the bottom, top, and riser portion of the vessel by an approximate 1 to 1-1/2-in-thick layer of molded ceramic fiber insulation. The portion of the shell above the melt pool is lined with a high (approximately 90%) alumina refractory.

Melter Heating System

There are several separate heating systems. These systems include:

- Electrodes. During operation, the glass is maintained in a molten condition by passing a current between electrodes through the resistive glass pool. As a current is introduced, the high resistance of the glass converts the electrical energy into heat.
- Dome heaters. The melter vessel shell is penetrated in the vapor space by dome heater rods. During normal operation, the dome heaters evaporate water in the feed slurry, supply heat to the glass for startup of the melter, and radiate heat to the vapor space and the melt surface during operation.
- Riser/pour spout heating. The riser heater consists of a strip heater that surrounds the riser channel. The pour-spout heater also consists of a strip heater that surrounds the pour spout channel. Current passing through these strip heaters maintains the glass at temperatures sufficient to allow it to flow through the riser and pour spout channels.
- Drain valve heating. Independent heaters surround the tube that provides the drain flow path. Only the upper zone 1 heater is used (as necessary) during normal operations to minimize heat loss through the bottom glass pool.

Melter Vapor Space Temperature Instrumentation

The Melter Vapor Space Temperature Instrumentation is comprised of a thermowell and thermocouple assembly installed near the melter shell to measure melter vapor space temperature. It has an integral conductivity probe at the lower end. There are redundant thermocouples installed at the same elevation in the melter vapor space.

Top Head Components

The melter top head components include:

- Feed tube
- Bubbler(s) – increases melt pool convection and thus melt rate – optional (may also be used to measure glass level – optional)
- Level dip tube – measures the glass level in the melter (may be installed as a multifunctional level dip tube/bubbler)
- Primary off-gas line
- TV camera(s) – remote viewing of the glass melt surface - optional
- Backup off-gas system/line to seal pot
- Vapor space thermowell / optional conductivity probe – measures the temperature of the melter plenum above the glass surface / provides indication of foaming
- Melt pool thermowell(s) – measure temperature of the glass pool (may be installed as a multifunctional melt pool thermowell / bubbler) – optional
- Melter glass pump – optional

Drain Valve

The melter drain valve assembly provides a way to empty the melter in the event of pour-spout pluggage, or at the end of melter life. The drain valve has zone heaters spaced along the drain path. The drain valve does not need to be functional for normal melter operations.

Inner Canister Closure Station

The inner canister closure station (ICCS) is located at the north end of the melter cell. A leak check is made on the temporary inner canister closure seal to demonstrate that the plug will keep water and/or moisture out of the canister during decontamination. After a bell jar has been sealed to the canister flange, the inner canister closure seal is leak tested with helium. If the leak rate of the seal exceeds the limit, the faulty plug is dropped into the neck by heating the canister flange, and a new plug is installed. The canister is retested before it is moved to the Canister Decontamination Cell (CDC). In the event a plug has been partially or abnormally installed, a plug retrieval tool in conjunction with the ICCS heater may be used to pull the plug out of the canister neck.

Process Support Equipment

Process support equipment includes:

- A water-actuated jet eductor pulls a vacuum on the pour spout, creating a negative pressure in the pour spout relative to that in the melter plenum. This negative pressure initiates glass pouring.

- A seal pot in the system that vents to the cell mitigates excessive pressure surges in the melter. Refer to Subsection 6.1.7.7 for more details.
- A closed-loop melter cooling water system maintains the melter shell at temperatures to avoid thermal updraft and resultant contamination of the MPC Crane.
- The melter/pour-spout pressure differential controls glass pouring. A catch pan is provided to collect inadvertent spills.
- The melter is connected to both primary off-gas and backup off-gas systems, which keep the vessel under a slight negative pressure and prefilter the off-gas before it is discharged to the sand filter.
- The cell floor is sloped to a sump with a dip tube for level indication.
- The cell contains manual and telerobotic manipulators.

5.2.3.4 Melter Off-gas Treatment Facilities

FUNCTION

The primary function of the melter off-gas treatment system is to reduce the amount of radioactive particles and mercury in the vapors that evolve from the melter before their release to the Zone 1 ventilation exhaust system. Melter off-gases are drawn and quenched by a quencher and discharged into the Off-gas Condensate Tank (OGCT). The quenched gases from the OGCT are scrubbed in the two-stage Steam Atomized Scrubber (SAS) and cooled by a chilled water condenser (Note that cooling water may be used if process chilled water is not available). Gases from the condenser then pass through the High Efficiency Mist Eliminator (HEME) and a set of HEPA filters before they are discharged by the Off-gas Exhauster into the building Zone 1 exhaust tunnel.

COMPONENTS

Melter off-gas treatment equipment is located in the chemical process cell, backup off-gas cell, and the melt cell. The off-gas system maintains a negative pressure relative to the cell atmosphere to control radioactive contamination.

The treatment process includes two parallel systems of equipment. The off-gases are normally processed through one line of equipment, which has been designated as the primary system. Treatment of the off-gases is switched to the backup system when necessary for repair or replacement of primary off-gas components. Automatic switchover from the primary to the backup off-gas system occurs when process conditions warrant.

The melter off-gas treatment facilities include the following:

- The Off-gas Film Cooler (OGFC) and Backup Off-gas Film Cooler (BUOGFC) are slotted pipe assemblies through which cooling air and steam (as necessary) can be injected. They are the inlet to the off-gas treatment systems, and are mounted on the melter lid. The film cooler reduces the temperature of the off-gases and thus reduces

the potential for pluggage of the off-gas piping. The film cooler on the system being used to vent the melter (normally the primary film cooler) introduces the air and steam (as necessary) to cool and dilute the off-gas. The other film cooler (normally the backup film cooler) adds air into the melter for oxidation.

The film coolers are specifically designed to avoid deposition of hard glassy deposits. A laminar film of air causes any accumulated solids to be friable. The solids can then be easily removed by a mechanical cleanout brush, which is placed on top of the film cooler when cleaning is required.

- Air to the film coolers comes from two separate piping systems, the film cooler and the film cooler purge air system. The air supply for these two systems is the critical plant air supply. If the Total Melter Air Flow Meter or Backup Off-gas Film Cooler Air Flow Meter detects low air flow, the hardwired interlock will stop the melter feed pumps. This interlock function is independent of the redundant DCS interlocks. Each of these flow meters is supported by its own Off-gas Film Cooler Air Pressure Indicator to assure proper operating pressure for maintaining accurate flow indication.
- A pair of Low Steam Pressure Switches, located on each steam line to the OGFC and BUOGFC, monitors the pressure to ensure air going through the OGFC and BUOGFC does not get diverted by flowing back into a failed steam line. Upon low pressure, these redundant pressure switches activate the hardwired interlock through LCS 251 to stop the melter feed pumps.
- Flow restricting orifices are installed in the air lines to limit air flow through a failed air line supporting other users (i.e., cameras or seal pot).
- A film cooler brush assembly can be used to remove accumulations of deposits that could plug the OGFC. A brush assembly can be used on the BUOGFC as well.
- The off-gas quencher is a large-scale eductor (jet pump) located in the melter cell. Its purpose is to cool the off-gases below the dew point. This condenses the steam coming off the melter before subsequent scrubbing and filtering. Cooling is accomplished by contacting the hot off-gases entering the quencher with cooled condensate that is pumped from the OGCT. The quencher pump is located on top of the OGCT. The condensed steam is collected in the OGCT where it is cooled and recirculated to the quencher. There is an identical quencher in the backup system.
- The OGCT is a collection tank that collects overflow from the seal pot and condensate from the quencher, the steam-atomized scrubber, the condenser, and the high efficiency mist eliminator. The tank is provided with cooling coils to regulate condensate temperature and a tank agitator to suspend solids. The condensate is used as quench water in the quencher, and as scrubbing water in the steam-atomized scrubbers, and as a motive fluid for the melter spout jet eductor. Pumps are provided for each of the above uses as well as for providing a liquid sample to the laboratory.

  The OGCT is provided with instrumentation to monitor condensate and vapor temperature, condensate density, and condensate level. A transfer pump is provided to

transfer condensate from the OGCT to the Recycle Collection Tank (RCT). The noncondensed off-gas is drawn into the steam-atomized scrubber.

The bottom of the off-gas condensate tank is designed to include a sloped mercury accumulation trough.

There is a similar tank on the backup system with some differences. The backup off-gas condensate tank (BUOGCT) does not include a melter spout jet pump and eductor, which are required to pour glass. Also the BUOGCT can receive contaminated melter cooling water, but does not receive overflow water from the seal pot.

A vacuum relief valve is located between the off-gas condensate tank and the steam atomized scrubber on both primary and backup systems. Its purpose is to vent air into the system, at a set pressure, to prevent a large vacuum from airlifting water from the melter seal pot into the melter.

- The SAS is a two-stage scrubber that removes submicron and micron-size particulates from the melter off-gas. Condensate from the OGCT is circulated to the scrubber and is atomized with steam. The atomized condensate is mixed with the off-gas in a horizontal mixing tube to wet and coalesce the particulates. The particulates are removed using a cyclone separator that drains to the OGCT. There is an identical scrubber in the backup system. The application of the steam and/or condensate depends on the decontamination factor required, performance of HEME, or other operational conditions.

- The off-gas condenser and de-entrainer separates the condensables in the off-gas stream and removes elemental mercury. The condenser reduces the temperature of the off-gas using process chilled water (or cooling water if process chilled water is not available). The flow of the chilled water is regulated to maintain the exiting off-gas temperature. A de-entrainer separates any vapor-suspended liquids from noncondensable gases. Condensed liquids are returned to the OGCT. There is an identical condenser and de-entrainer in the backup system.
- The HEME is a vessel containing glass fiber filters. The filters remove fine mists and particulates from the off-gas stream. Off-gas enters the top of the HEME vessel and exits from the side. An air-atomized water spray is available to wet filters and remove soluble particulates. The HEME filters are replaceable remotely. There is an identical HEME in the backup system.
- The Heater/HEPA filters assembly is a two-stage filter that removes the remaining submicron-size particles from the off-gas. To prevent an excessive pressure drop across the filter from moisture condensation, the off-gas is preheated to raise its temperature above the dew point before it enters the filter. The HEPA filter is replaceable remotely. There is an identical HEPA assembly in the backup system.
- The exhauster draws the melter off-gas through the off-gas treatment system. A vent valve (located at the SAS inlet jumper) is provided for exhauster protection during startup and switchover. The exhauster discharges the treated off-gas to the sand filter

through the building exhaust tunnel. There is an identical exhauster in the backup system.

- Plant air is injected into the primary off-gas film cooler to dilute the concentration of flammable gases in the melter off-gas to below the LEL.
- Plant air is injected into the BUOGFC to promote combustion in the melter plenum.

5.2.3.5 Mercury Purification Cell

FUNCTION

Mercury treatment equipment is provided for decontamination and purification of recovered mercury that is separated as a product from the waste feed. The equipment is located in the shielded mercury purification cell and in the adjacent service room that contains the mercury purification hood. The cell is located on the west mezzanine level of 221-S, adjacent to the Analytical Laboratory. A mechanical transfer drawer and in-cell hoist service the cell.

COMPONENTS

Mercury decontamination and distillation components include:

- Pumps
- Mercury acid wash tank
- Vacuum still and condenser
- Mercury scrub column
- Distillation hood
- Mercury hold tank
- Spent wash tank

Periodically, liquid mercury is transferred from the MWWT to the Mercury Acid Wash Tank (MAWT) and washed with nitric acid to remove contaminants. A final scrub is provided by passing mercury counter-currently through packed columns with nitric acid and water scrub streams. Final distillation may optionally be performed in a vented hood. The purified mercury is loaded into containers. Wash solutions are transferred to the Decontamination Waste Treatment Tank (DWTT) for recycling to the tank farm. The decontamination process through water washing is handled remotely with manipulators.

Distillation is done in a hood. A hood airflow alarm is installed to warn personnel of HVAC exhaust failures or deficiencies, and an Area Radiation Monitor (ARM) is installed to warn personnel if high radiation fields develop in the distillation room.

Additional features for the facilities in the mercury purification cell include the following:

- Gases from the mercury purification system are vented to the CPC Cell.

- Seal pots and other devices are used on nonpressurized cold service lines that enter the cells to prevent backflow of contaminated material.
- Subsection 5.4.10 gives a description of the fire protection system.

A description of the mercury recovery process is detailed in Subsection 6.1.9.

5.2.3.6 Process Vessel Ventilation System

FUNCTION

The Process Vessel Ventilation (PVV) system collects, decontaminates and discharges the gases from in-cell process vessels to the Zone 1 exhaust system. Its functions are described in Subsection 6.1.6. The PVV system serves all in-cell process vessels and canister decontamination chambers except the melter, which has its own off-gas treatment system.

COMPONENTS

The process vessel ventilation system components include the following:

- Vessel vent heater
- Mercury transfer header
- Formic acid vent condenser
- Vessel vent filter
- Exhausters (2) with respective upstream motor operated isolation valves

Particulate materials are removed from the vent gases in a vessel consisting of fiberglass-packed bed filters in parallel.

Two exhausters (one a backup) provide the motive power for the vent system and discharge to the Zone 1 exhaust tunnel.

Additional features of this system include the following:

- The process vessel ventilation system is operated at a negative pressure with respect to the cell pressure. The PVV is equipped with a baseload air valve.
- The system has sampling capabilities.

5.2.3.7 Recycle Waste Collection Facilities

FUNCTION

Recycle waste collection equipment is located in the CPC and provides the capability to collect, treat, and transfer waste solutions which result from CPC operations, off-gas operations, decontamination operations, and collection of miscellaneous fluids in sumps. There are three

headers for process solutions: 1) formic acid waste header – formic streams go to the RCT, 2) hot decon waste header – decon streams go to the DWTT, and 3) warm decon waste header – potentially contaminated streams go to the DWTT.

COMPONENTS

Recycle waste collection facilities components include the following:

- Sumps
- Sump pumps
- Hot decontamination waste header
- Warm decontamination waste header
- Formic Acid Waste Header
- Decontamination Waste Treatment Tank (DWTT)
- DWTT reflux condenser
- Recycle Collection Tank (RCT)
- Transfer pumps
- Sample pumps
- Agitators
- Cooling coils (RCT)
- Steam and cooling coils (DWTT)

Sumps are either C-276 or stainless steel lined. Liquid in the sumps is removed using pumps.

The DWTT is a vertical cylindrical tank. The bottom of the tank is sloped to a sump.

Equipment is provided for adding nitric acid and NaOH, and for mixing and cooling the solution. A sample pump is used to obtain materials for analysis. Cooling is provided by the closed-loop cooling water system and a cooling coil; a steam coil is provided for heating. Provisions are made to dissolve HEME and HEPA filters in the DWTT.

The DWTT reflux condenser is located on top of the DWTT.

The recycle collection tank collects material to be transferred to the tank farm. The RCT is a vertical cylindrical tank. The bottom of the tank is sloped to a sump for mercury collection. Equipment is provided to agitate, cool, sample, and transfer the solution. Waste is neutralized, and corrosion inhibited before it is returned to the tank farm.

Additional features for the recycle waste collection facilities include the following:

- Formic acid waste is collected and routed to the recycle collection tank via the formic acid waste header.
- A two-foot high dike surrounds the DWTT and its contained sump to segregate any liquids escaping from the tank from other liquids in the CPC.
- Seal pots and other backflow-preventing devices are used on all lines connected to nonradioactive streams.
- Cooling and steam coils are maintained at a positive pressure relative to the radioactive side.
- Upon low purge flow in the DWTT, interlocks stop steam flow and initiate process cooling water flow.

5.2.3.8 Canister Decontamination and Weld Test Cells

FUNCTION

Equipment for canister decontamination, smears for detectable transferable contamination, and canister closure welding are included in this area. The following functionality is provided:

- Canister outer surface temperature measurements.
- Canister surface decontamination.
- Transferable contamination checks after decontamination.
- Canister transfers between stations.
- Pressing of the inner canister closure plug into the neck of the canister.
- Welding of the weld plug for final canister closure.
- Final inspection of the canister and weld (visual).
- Final canister surface contamination checks before transferring the canister to the canister exit tunnel transfer car.

Space has been reserved in the weld test cell for a canister overpack welder, should the need for one be identified.

COMPONENTS

Canister Decontamination Cell (CDC)

The equipment associated with slurry cleaning of the exterior of the canisters (to remove radioactive contamination) is located in the CDC. The following components are involved in these operations:

- An overhead bridge crane with a canister grapple.

- A temperature probe.
- Canister storage racks.
- Two decontamination chambers and associated recirculation and transfer pumps, spray nozzles, piping, instruments, and Canister Manipulating Mechanism (CMM).
- A cell sump pump.
- CCTV cameras to assist in-cell viewing.
- Cell lights and shielded viewing windows.
- Manipulators.

Canister decontamination begins after the surface temperature of the canister is below 100°C. The canister is placed in a decontamination chamber. Two identical stations are provided. Either chamber can be used for canister decontamination. Canister decontamination is accomplished using an air-injected frit-slurry. The frit-slurry is pumped to the decontamination chamber nozzles, where it is injected into a compressed air stream and accelerated onto the canister surface. After cleaning, the canister is water rinsed and then dried. Canisters will be transferred to the CDC Smear Test Station (CDCSTS) to be surface smeared for contamination. Canisters that fail the smear test are returned to a decontamination chamber for decontamination. The process is repeated until the canister passes the smear check.

<u>CDC Smear Test Station</u>

Following canister decontamination, smear testing of the canister exterior is performed in the CDC smear test station to ensure canister cleanliness. The following equipment is employed:

- A smear test station.
- Manipulators.
- A pneumatic transfer system.
- A radiobench hood with a receiving terminal for the pneumatic transfer system.
- A trolley.

The CDC smear test station is located in the south end of the CDC/WTC transfer tunnel. The smear test station positions the canister for smearing. Manipulators are used to take smears of the canister. After smears are taken, they are transferred through the shield wall to a receiving terminal in the radiobench hood by the pneumatic transfer system.

When the canister has passed the smear tests for CDC smearing, it is moved by the smear test station trolley to the exit pedestal.

If the canister does not pass the smear test, it is returned to the CDC for further decontamination.

The CDC smear station can be fully shielded from the CDC and the WTC so that when canisters are removed, the tunnel can be entered for contact decontamination and maintenance of smear station equipment.

Weld Test Cell (WTC)

The weld test cell contains equipment used to press the previously installed inner canister closure plug down into the neck of the canister, place and weld the final seal plug into the canister, and smear and inspect the sealed canister. The following components are involved in WTC operations:

- The ICC press station with a control cabinet.
- The upset resistance plug welder with a control cabinet.
- The canister trolley capable of transferring the canister between the ICC press and plug welder stations.
- Manipulators to remotely handle the weld plug and associated tools.
- The weld plug delivery chute through the WTC wall near the canister trolley.
- The WTC smear test station.
- Two overhead bridge cranes. The cranes are mounted on separate tracks, one crane above the other.
- A shielded storage enclosure with four canister storage positions.

Canisters arrive in the WTC via the CDC-WTC transfer tunnel or through the Vitrification Building Canister Exit Transfer Tunnel for canisters being returned to the WTC. A WTC crane is used to lift the canister from the pedestal in the transfer tunnel into the WTC and to position the canister in the canister trolley of the plug welder system.

The inner canister closure plug is pressed into the neck of the canister using a hydraulic press, and the final closure of the canister is made by welding a solid plug into the canister nozzle using an upset resistance welder.

The ICC press and welder are controlled from control stations located in the corridor. The welder is served by power packs. The press and welder have been designed for hands-on maintenance through the airlock adjacent to the west wall of the WTC. A controlled force is exerted to achieve electrical contact and complete the circuit through the welder ram, the plug, the canister flange, and the lower electrodes. Once welded, the canister is removed from the welder by the canister trolley. A WTC crane then transfers the canister to the WTC smear test station for final inspection and surface contamination checks.

Smear samples from the smear test station in the WTC are sent via a pneumatic transfer system to the same radiobench hood serving the CDC smear test station.

The WTC is shielded from the other cells in the facility. When canisters are not present in the WTC or when they have been placed in the shielded storage area within the cell, it is possible to enter the cell to perform hands on maintenance activities.

5.2.3.9 Equipment Decontamination and Maintenance Cells

FUNCTION

The equipment decontamination and maintenance facilities consist of two dedicated cells, the Remote Equipment Decontamination Cell (REDC) and the Contact Decontamination and Maintenance Cell (CDMC). In these facilities, equipment from the vitrification process and supporting cells (including LPPP) can be decontaminated in a controlled fashion, using both remote and contact techniques. Usually, decontamination is first remotely performed in the REDC until a sufficiently low contamination level is reached. After that, final contact decontamination and/or maintenance can be performed in the CDMC. If the contamination level is sufficiently low, the equipment may be moved directly to the CDMC without going through the REDC. Equipment can be moved from either the REDC or CDMC to the railroad well.

COMPONENTS

Decontamination facilities are at the south end of Building 221-S. The CDMC walls provide sufficient shielding to allow personnel access to the CDMC during normal DWPF operation. The REDC is not designed for personnel entry. Three shielded viewing windows are provided in the east wall of the CDMC. Four shielded viewing windows are provided in the east wall of the REDC.

REDC components include:

- Portable holding frames and equipment supports for temporary use while equipment is being decontaminated and/or serviced (moved into and out of cell as needed).
- Wall-mounted Electromechanical Manipulators (EMMs).
- Remotely manipulated decontamination steam and dry ice (CO_2) pellet spray wands.
- Decontamination fluid service.
- Vessel emptying equipment (pumps).
- Decontamination solution collection sump and pump.
- Utilities.
- Radiation detectors.
- A portable tank for soak decontamination of process equipment.
- A CCTV camera and camera mount.
- Manipulators.

Structural stainless steel frames are provided to hold process equipment while it is being decontaminated or disassembled. Equipment may be provided to disassemble components and permit direct access to parts that cannot be decontaminated by simple external spraying. The floor to the cell is sloped sufficiently to ensure that fluids drain to the sump.

The wall-mounted EMMs are used for handling the decontamination spray wands. They may assist in placement of pumpout jets or pumps into tanks and handle positioning of equipment and tools during cleaning and disassembly operations.

The steam jet spray wands are designed to be held by the EMMs. They are used for washdown of vessel and equipment surfaces. Decontamination fluids are supplied to the wands from outside the cells through penetrations in the cell walls. The steam spraying can utilize water, acid, caustic or other decontamination solutions, singly or in combination. These same solutions can alternately be fed to a rotary jet cleaner for decontamination of interior surfaces of a process vessel.

In addition, dry ice pellets can be delivered through two separate manipulator wall ports as another means of decontamination.

Equipment is provided for emptying liquids from a vessel that is being decontaminated or from the decontamination cell sump. Liquids are discharged to the Decontamination Waste Treatment Tank (DWTT) in the chemical process cell.

CDMC components include:

- Both fixed and portable holding frames and equipment supports for temporary use while equipment is being decontaminated and/or serviced. This support equipment includes a pump maintenance stand, a pump run-in tank and an agitator maintenance / run-in stand.
- A bridge crane for moving and positioning equipment within the cell.
- Steam and dry ice (CO_2) pellet decontamination equipment.
- Decontamination fluid service.
- Welding equipment.
- Decontamination solution collection sump and pump.
- Utilities and lighting.
- Work benches, small tools, and storage.
- A monorail-mounted hoist for transferring equipment between the cell and the cell entrance airlock.
- CCTV equipment and controls.
- Area Radiation Monitors (ARMs).

Portable holding frames and equipment supports are provided for many process cell components for easier decontamination and servicing.

Manually operated steam cleaners are provided to perform high pressure spraying of equipment with steam, water, acid, caustic, or in-house blended decontamination solutions. Ultrasonic cleaning may also be used as a decontamination method. In addition, dry ice (CO_2) pellets can be delivered through a manipulator wall port as another means of decontamination.

The CDMC has a sump to collect spent decontamination solutions.

Personnel breathing air stations are provided in the entry air lock, as an air supply for radiation protection equipment such as plastic suits. Three shielded viewing windows are present to allow personnel to observe operations within the cell.

5.2.3.10 Distributed Control System

Much of the monitoring and control of the DWPF process is accomplished by the Distributed Control System (DCS). The system is capable of performing direct digital and/or analog control via operator workstations as well as sequential or batch control. The system is also capable of recording process data and transmitting data over a digital communications link to other system interfaces.

Each device utilized by the DWPF process has been reviewed to determine if inadvertent operations have the potential for a Process Hazards event. For devices where this potential exists, hard-wired interlocks have been provided, which are independent of the DCS. These interlocks use process sensors and relay logic to disable the device whenever an unsafe condition exists. This logic is independent of the DCS and cannot be overridden by the DCS.

Additional features of the DCS include the following:

- The DCS equipment is powered by several Uninterruptible Power Supplies (UPSs). This is necessary to provide clean, uninterrupted power to the computer based process controllers. These UPSs are sized to provide power for at least 2 minutes after the input power is lost.
- Fire protection, alarming, and appropriate suppression systems are provided for all DCS equipment.
- The environment of DCS equipment spaces is temperature controlled. Over-temperature detectors installed in DCS cabinets generate an alarm before equipment operating temperatures are exceeded.

5.2.3.11 Cell Cranes and Auxiliaries

FUNCTION

Cranes provide remote handling capability for installing and removing in-cell equipment and for in-cell material handling operations.

COMPONENTS AND OPERATING CHARACTERISTICS

MPC Crane

The Main Process Cell (MPC) Crane is an overhead bridge crane located in the upper part of the RPC in the Vitrification Building inside the Main Process Cell Canyon. The Main Process Cell Crane Structural Support consists of a 54-foot bridge span and a runway. The bridge span consists of two girders that span the width of the canyon and travels on the runway rails on and slightly above the third level of the Vitrification Building. The MPC Crane runway is an assembly of rails supported by sole plates which are secured to concrete corbels. Two end trucks are located on each end of the bridge that consist of a frame, bearings, wheel shafts and wheels that support the bridge girders.

The MPC crane is equipped with a stainless steel Electrical Equipment Compartment (EEC), with an integral airlock on one end. A ventilation system, which maintains the interior of the compartment at slightly positive air pressure (for contamination control), supplies filtered air for dissipating the heat generated by the compartment components and filters the exhaust air returned to the bus bar corridor.

The MPC Crane is designed to be operated by remote control in a highly radioactive environment. For maintenance, the crane is moved into a shielded crane maintenance area where it is decontaminated, as required, then serviced.

Control of all crane motion is accomplished remotely from the Building 210-S crane operator control console or the Building 221-S crane maintenance console. The crane operator views the operation of the crane and hoist motion on CCTV monitors through on-board cameras. Capability to operate the crane from the EEC is also provided.

Melt Cell and Canister Decon Cell Cranes

The melt cell and canister decon cell cranes are overhead bridge cranes located just below the cell covers in each cell. Crane and hoist motions are controlled from a console at the shielded viewing windows with visual observation through the shielded viewing windows supplemented by in-cell TV camera viewing.

Weld Test Cell (WTC) Cranes

Two nearly identical overhead bridge cranes are located in the WTC. One crane is mounted above the other on a separate parallel runway providing the same cell coverage. Crane and hoist motions are controlled from a control panel in front of the shielded viewing windows with visual observation through the shielded viewing windows supplemented by in-cell TV camera viewing or from inside the WTC when canisters are not present. Both cranes are designed for hands-on contact maintenance and repair by personnel who enter the WTC after all canisters are placed in shielded storage.

The lower crane normally performs in-cell work. The upper crane is used to backup the lower crane in case of failure since the MPC crane has only limited access to the WTC.

5.2.3.12 Regulated Maintenance and E&I Shops

The regulated maintenance and E&I shops provide suitably equipped locations where equipment can be serviced and repaired.

Regulated shops include the following:

- Regulated Maintenance Shop 1
- Regulated Manipulator Repair Shop 2
- Crane Maintenance Area (CMA)

The CMA is separated from the remote processing cells by a vertical shield door. The CMA has the following facilities and features:

- A floor sloped to provide drainage to the sump.
- Sump with sump pump discharging to the DWTT via the hot decon waste header.
- Shielded viewing windows for observing maintenance activities.
- Radiation monitoring instruments.
- A breathing air supply.
- An underhung bridge crane.
- Spray lances, nozzles, valving, and flexible hoses.
- Utility services.

5.2.3.13 Radiological and Chemical Monitoring Facilities

FUNCTION

These facilities are provided for the safety of plant personnel and visitors as well as other personnel onsite and the general public. Monitoring systems have been designed to detect radioactive and chemical materials so that corrective actions may be taken to prevent the materials from entering plant effluents, such as air, water, sewage, solid waste and stack gases.

Radiation monitoring instruments are used to monitor ambient radiation and airborne radioactivity levels and to detect and control the spread of radioactive contamination. Personnel survey instruments are also located where needed for personnel exiting contamination areas.

The Radiological Control (RC) facility at the DWPF provides space and equipment to:

- Monitor, record, and administratively control personnel radiation exposures.
- Measure and record necessary radiation data from samples, smear tests, etc.
- Provide necessary RC administrative services.
- Decontaminate, store and source check portable RC instruments.

Instrumentation required for emissions control monitoring (both radiological and chemical) at final air/water/solids release locations is also provided.

COMPONENTS

The following types of permanently installed radiological monitoring equipment are used for the Vitrification Building:

Area Radiation Monitors

Area Radiation Monitors (ARMs) are located in frequently occupied locations with the potential for unexpected increases in dose rates and in remote locations where there is a need for indication of dose rates prior to personnel entering remote locations.

Radiation detectors are located near the sources of radiation and transmit signals to areas removed from the radiation sources. Signals from these measuring instruments are carried by the Distributed Control System (DCS). Each ARM is equipped with an alarm switch to activate annunciators located near the sensor and, where appropriate, near the access door to the monitored area.

Continuous Air Monitors.

There are beta-gamma Continuous Air Monitors (CAMs) that measure radioactive particulates in the air by pulling a sample of air through a sample filter. The airborne radioactivity is collected on the sample filter which is monitored by a beta-gamma sensitive detector, which provides gross activity measurements. CAMs that monitor for alpha radiation may also be used. Vacuum for the CAMs is supplied by a central vacuum system.

Air Samplers

There are Air Samplers located in areas of low contamination potential and in air locks to detect unexpected contamination. Some air samplers are connected to a central vacuum system. The sample filters are replaced regularly and checked for collected radioactive materials.

Airborne Radioactivity Sampling in Normally Nonaccessible Areas

Sampling capability is provided in various process and equipment repair cells.

Liquid Radioactivity Effluent Monitor

The swirl cell provides radiation monitoring of the water in the cooling tower return line. The swirl cell radiation detector sends an alarm to the Central Control Room via the DCS if the radiation monitor detects abnormal amounts of activity.

Effluent Airborne Monitors

The Zone 1 and Zone 2 effluent air is sampled periodically in accordance with the requirements of Chapter 7.

In addition to the radiological monitoring facilities, the catch tank area has a gas monitoring system that monitors the air for hazardous (combustible) vapors and oxygen concentrations.

The Radiological Control (RC) unit is located in Service Building 210-S. Space is provided for the RC facilities adjacent to the main entry-and-exit corridor. The following are also included in the RC unit: RC Counting Room for analyzing contamination and air samples, a small laboratory for water sample analysis, a room for decontamination of portable instruments, two personnel decontamination stations, and separate change room facilities for both men and women. The RC counting room is designed to have a low background radiation level.

RC equipment is periodically inspected and tested according to SRS requirements.

Exhaust air from the RC office, Laboratory and Counting Room, including laboratory hoods, is passed through HEPA filters prior to discharge to the atmosphere.

Monitoring wells are provided for obtaining water samples and for detecting and monitoring any inadvertent releases of radioactivity from the various confinement structures to the ground. A pair of wells (one deep and one shallow) is provided at each end of each expansion joint in the Vitrification Building. In addition, deep wells are located at the north and south ends of the Vitrification Building. The wells are located as close as practical to the walls of the building (about 10 ft).

5.2.3.14 Analytical Facility

The shielded analytical facility is discussed in detail in Subsection 6.5.5.

5.2.3.15 Railroad Well and Airlock

FUNCTION

Equipment is moved in or out of the Vitrification Building by way of the railroad well. From the railroad well, the item can be shipped after proper packaging. These shipments are conducted consistent with the Radiological Protection Program.

COMPONENTS

The railroad well and airlock are located at the south end of the Vitrification Building. The railroad well is constructed of three reinforced concrete walls. The south end of the railroad well is open. Concrete shielding covers with stepped joints are provided over the railroad well to shield against radiation from the canyon process area and to control airflow into Zone 1 of the process area.

The railroad airlock connects to the open south end of the railroad well. It is constructed of steel superstructure with metal siding. The south end of the airlock contains a door large enough to accommodate the railcars.

Additional features for the railroad well and airlock include the following:

- The railroad well is equipped with a sump and sloped floor to facilitate drainage into the sump.
- Concrete shielding covers with stepped joints are provided over the railroad well.
- Ventilation air is supplied directly to the area for personnel.
- Administrative controls are used to control access to the railroad well when the shield covers are removed.
- Administrative controls assure that personnel in areas adjacent to the railroad airlock will not be exposed to high dose rates when large sources (see Section 5.5) are being handled in the railroad well.

5.3 SUPPORT FACILITIES

5.3.1 STRUCTURAL CRITERIA

The categories to which the facilities were designed are discussed in Subsection 5.1.2.

5.3.2 SUPPORT FACILITIES DESCRIPTIONS

5.3.2.1 Sand Filter and Exhaust Air Tunnels

The sand filter is located west of the Vitrification Building. Space is reserved for future expansion west of the sand filter if excessive pressure drop occurs or if there is a need for additional air filtration capacity.

The sand filter and tunnels are Category I structures and are made of reinforced concrete. Exterior walls below grade are damp-proofed, and the roof is covered with an elastomeric waterproofing system. Air lock access to the sand filter is provided for inspection.

Two underground inlet air tunnels from the Vitrification Building merge into one underground tunnel which connects to the sand filter. One exhaust air tunnel, partially underground and partially aboveground, 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 pulled through the inlet air tunnels and the sand filter by fans in the fan house. Air enters the sand filter underneath the filter bed through distribution troughs spaced along the length of the building. Air passes up through the graded filter bed to an open space at the top, just under the roof slab, and exits through the exhaust tunnel leading to the fan house. In the fan house, the fans discharge the air past a sampling station to the exhaust stack.

Seven graded layers of rock, gravel, and sand are placed in the sand filter to remove particulates carried by the ventilation air. A stainless steel grating placed over the lateral air distribution troughs supports the filter media.

Stainless-steel-lined sumps placed at low points in the sand filter air inlet and outlet tunnels serve as collection points for condensate or water entering the structure. The inlet tunnel collection sump receives liquid from the drains located in the north, east, and west exhaust tunnels, as well as the sand filter air inlet and outlet sumps. Since this water may be contaminated, it is returned to the Vitrification Building through a stainless steel transfer line.

Instrumentation is provided to measure air flow rates and the pressure drop through the sand filter. Monitor tubes for radiation profile measurements, pressure taps in the filter bed media, and air sampling taps in the filtered and unfiltered air spaces are provided. Provisions are also made for injecting aerosol into the incoming air supply to determine filter efficiency.

5.3.2.2 Fan House

Zone 1 exhaust fans are located in the fan-house building. The fan house is a Category I reinforced concrete structure designed as a maximum resistance facility to survive loading conditions encountered during natural phenomena such as tornadoes or earthquakes. This structure also houses standby generators, electrical equipment, and diesel fuel day tanks. Air inlet and exhaust tunnels, located under the fan room, connect to a tunnel from the sand filter, and to an above-grade duct to the exhaust stack.

An air sampling station was originally provided on the west side of the building but currently is not used. An emergency relief port, located on the exhaust duct, can be opened if needed. The exhaust duct from the relief port to the exhaust stack is standard construction and has been seismically qualified. An air sampling station is provided on the exhaust duct.

Exhaust ventilation is provided for the exhaust fan room. HVAC is provided for the two electric rooms, the FOS room, and the air sampling station room (currently not used for sampling).

Some equipment in the fan house is normally controlled and monitored from the central control room in the 221-S Vitrification Building. The remaining equipment can be controlled from the local control stations in the fan house. Monorails are installed to support maintenance activities of the exhaust fans, standby generators, and HVAC equipment.

5.3.2.3 Zone 1 Exhaust Stack

The Zone 1 exhaust stack is a standard construction steel structure that has been seismically qualified and is located southwest of the fan house.

The height of the stack from the top to the concrete foundation is 147 ft to provide elevated release and preclude released radioactive materials from being drawn back into the Vitrification Building air inlets. An inspection port is provided at the bottom of the exhaust stack.

5.3.2.4 Glass Waste Storage Buildings

The Glass Waste Storage Buildings (GWSB #1 and GWSB #2) provide space for the safe handling and temporary storage of filled glass waste canisters while they are awaiting transfer to a permanent storage location. The GWSBs are located northwest of the Vitrification Building. Each of the GWSBs has four areas inside the building: a storage vault, an operating area above the vault, air inlet shafts, and air exhaust shafts.

The GWSB #1 has additional areas attached to the main portions of the building. The office area is south of the operating area. The Electrical Equipment Room (EER) and the FOS room are adjacent to the west side of the office area. The inspection gallery is attached to the west side of the air exhaust shafts. HVAC equipment is located outside and adjacent to the west side of the inspection gallery, the north side of the operating area, and the south side of the FOS room.

GWSB #1 is also capable of housing two canisters per storage position after being modified, thus increasing the maximum storage capacity of GWSB #1 from 2286 to 4572 canisters. The

modifications include replacing the original canister support crossbar and concrete shield plug with a support plate and shorter metal shield plug, which will provide the head room necessary to double stack canisters. For more information see Reference 60 and 61.

The GWSB #2 has no office or inspection gallery. Its electrical equipment and FOS are located in a single room on the west side of the operating area. The HVAC equipment is located outside on the north side of the operating area.

The connecting road between the GWSBs and the Vitrification Building is designed for use by the Shielded Canister Transporter (SCT). Other vehicles also use this road. Traffic sharing of the road is administratively controlled.

The SCT transfers filled and decontaminated glass waste canisters to one of the GWSBs for storage.

The storage vault areas are designed to hold the glass waste canisters in a manner that ensures protection to operating personnel, the public, and the environment. Radiation shielding protection for personnel is provided by concrete walls, earth embedment, and a concrete deck that forms the floor of the operating area. The stored canisters are protected against external damage and are cooled to prevent internal heat buildup.

Resistance Temperature Detectors (RTDs) are located in each of the four compartments within the GWSB #1 vaults and thermocouples within the GWSB #2 vaults. These RTDs and thermocouples monitor the temperature of the concrete vault ceiling.

The galvanized GWSB canister supports are Category I (GWSB #1) or Performance Category 2 (GWSB #2) resistant structures fabricated of large diameter pipe sections that serve as storage cavities. The standard openings are laid out in a grid pattern, and the canister casings are supported by a concrete mat. Space between the pipes is covered with overlapping horizontally stepped steel plates to direct most of the ventilation air through the storage pipes.

The GWSB ventilation systems are discussed in Subsection 5.4.1.

Exterior damp-proofing is provided below grade. Any moisture present in the air intake shafts is drained from the vault to the sumps. A portable sump pump is provided to empty the sumps, each of which is equipped with level detection and an alarm.

The SCT operating area above the vault is enclosed in a Category III steel structure. It has uninsulated metal siding and an insulated roof.

The GWSB #1 concrete floor is treated to resist powdering or spalling due to movement of the SCT. There are 2,262 standard and 24 oversize plug openings in the floor in GWSB #1. There are 2,340 standard plug openings in the floor in GWSB #2.

For GWSB #1, an inspection gallery is located adjacent to the air exhaust shafts. Lightning protection and fire detection are provided. The inspection gallery is ventilated using power roof

exhausters with backdraft dampers, in addition to wall louvers with automatic dampers and filters. The gallery is provided with electric unit heaters.

There are emergency exits at each corner of the GWSBs. The operating area supply fans supply the ventilation air to the operating area to remove the fumes from the SCT's diesel engine and summer heat buildup. Gravity roof vents are provided for exhaust air relief. The diesel fumes and the summer heat is carried off by the air being relieved through these roof vents. No provision is made for heating the operating area.

The GWSB # 1 has three MCCs located in the EER. The GWSB #2 has only one MCC located in the EER/FOS room. Subsection 5.4.10 gives a discussion of the fire protection system.

SHIELDED CANISTER TRANSPORTER

The Shielded Canister Transporter (SCT) is used to move canisters between 221-S and the GWSBs and to relocate canisters within the GWSBs. The SCT can also be used to relocate canisters between the two GWSBs. The transporter supports a center module that includes a steel shielding cask and floor plug cavity with associated cask lifting and positioning equipment. The SCT also has canister and plug lifting equipment and associated controls. The main components of the SCT include:

- Transporter vehicle
- Operation cab
- Center module (comprised of the shielding cask, floor plug cavity, and canister and floor plug hoisting systems)
- Center module support frame
- Bridge and trolley
- Control and power system

The dual-type rubber tire wheels are filled with a low durometer resilient polyurethane rubber to prevent deflation. The transporter is powered by two diesel engines (one standby) which provide power to the SCT electric and hydraulic systems used to operate the transporter, center module, trolley, and bridge.

An on-board Fire Suppression System is installed in the SCT engine enclosures. The system is designed to suppress Class B fires within an enclosed volume. A discussion of this fire protection system is included in Subsection 5.4.10.

SDD CS-03 contains more detail for the SCT (Ref. 38).

5.3.2.5 Service Building

The Service Building is a steel-frame, standard construction building that abuts the east side of the Vitrification Building. It consists of two portions divided by a transverse bay that extends

east to a railway side loading area. The northern portion houses the personnel and control facilities for the Vitrification Building and the Service Building, along with a computer room, offices, and storage areas. The transverse bay houses the canister receiving and storage area, the maintenance facilities, mechanical room, electrical room, men's and women's toilets, and various offices. The southern portion of the Service Building houses five areas: the clean maintenance shop, clean E&I Shop 5, electrical room, a dry chemical storage area, and mechanical room. A compressed gas storage area is provided outside the building directly adjacent to the chemical storage area.

Safety showers and eye wash units are provided in the cold chemical feed storage room.

Phone service and communications systems are provided.

5.3.2.6 Vitrification Administrative Buildings

The administrative buildings include the Operations Building, Computer Facility, and various temporary satellite facilities serving as office facilities.

5.3.2.7 Interarea Transfer Lines

The Interarea Transfer Lines consist of buried (except one above ground portion of the incoming sludge line from Tank 40) pipelines connecting the Vitrification Building and H-Area facilities, with the Actinide Removal Process (ARP) mostly in 512-S (see Subsection 5.3.2.9) and the LPPP (see Subsection 5.3.2.8) at intermediate locations. The system transfers:

- MST/Salt Solution from H-Area to the LWPT in the 512-S Building
- MST/Sludge Solids from the LWPT in the 512-S Building to the PRFT in Vitrification Building via the LPPP-PPT
- Filtrate from the LWHT in 512-S to the Modular Caustic Side Solvent Extraction (CSSX) Unit (MCU)
- Sludge from Tank 40H to the Vitrification Building via the LPPP-SPT
- SE from MCU to the SEFT via the LPPP-RPT and PPT Cells
- Recycle from the Vitrification Building to the HDB-8 via the LPPP-RPT
- Decontaminated Salt Solution (DSS) from MCU to H-Area.

The Interarea Transfer Lines consist of lines with two 3-inch schedule 40 (schedule 10 in H-Area), type 304L stainless steel core transfer lines surrounded by a 10-inch, schedule 20 carbon steel jacket. Section 4.4.39 provides additional details of the Interarea Transfer Lines. Figure 5.3-2 shows a cross section of the Interarea Transfer Lines.

Portions of the DWPF Interarea transfer lines are physically located in H-Tank Farm Facility and therefore pose a Safety Analysis concern not only to DWPF but the tank farm as well. The Interarea Transfer Lines between DWPF and tank farm are within the scope of DWPF. In one case DSS from MCU to H-Area (up to and including seal plates) is within the scope of DWPF

but the waste flow is from one Tank Farm facility to another. Any change to the interarea transfer lines (either in their physical arrangement or in their function) must be reviewed by not only the DWPF Design Authority but also the H-Tank Farm Design Authority to ensure that there is not an impact on the H-Tank Farm DSA.

LEAK DETECTION

Each outer jacket drains to a LDB located adjacent to the Low Point Pump Pit (LPPP) or 512-S Facility. Each in-service transfer line is connected to an LDB which is equipped with a conductivity probe and diptubes that can be instrumented to determine the level of collected liquid. A drain line from the jacket connects into the top of the LDB and a second line is routed from the LDB into the adjacent cell, where any leakage can be drained into the cell sump. Each LDB drain line is normally plugged with a removable rod. Each LDB overflow line is also provided with a removable rod which is normally in the raised position. The overflow lines are plugged by lowering the removable rod to permit the connected jacket to be pressurized for leak testing.

5.3.2.8 Low Point Pump Pit

The Low Point Pump Pit (LPPP) is equipped with three pump tanks: the Sludge Pump Tank (SPT), the Precipitate Pump Tank (PPT), and the Recycle Pump Tank (RPT). The pump tanks are housed separately in contiguous concrete cells. The pump cells are below grade with the walls extending upward above the building floor. These cells are separated by shield walls and atmospherically connected through ventilation openings in the side walls of the center (recycle waste) cell. Each cell has seven removable concrete shield covers that form a barrier over the cell to protect and maintain the structural integrity of the cell and its contents. Access to the cells is achieved through the removal of the top concrete shielding covers. CCTV cameras are provided to monitor in-cell maintenance operations.

The cell floors have a slope for drainage purposes and a shallow trench at the low side for direct flow to the sump. Each sump is equipped with a level indicator. Cells are lined with a minimum thickness of 3/8-in. stainless steel on the floor and partially up the walls. The remainder of the walls has 1/4-in.-thick liners. The pump cells are equipped with individual underliner systems for draining and detecting leaks in the stainless steel floor liners. A system of drainage slots in the concrete under the liner conducts leaks into an underliner sump. Collected leakage flows out the bottom drain to the underliner sump that is equipped with a conductivity probe and pumpout capability.

TANKS

- Dimensions – 10 ft 2 in. tall and 12 ft in diameter
- Material of construction – SA240 type 304L stainless steel in accordance with ASME Section VIII, Division 1 with no Code stamp

PURGE SYSTEMS

The LPPP Primary Purge System, consisting of ambient vaporizers and liquid nitrogen storage tank (located east of 422-S), provides a nitrogen source. Nitrogen to the SPT, PPT, and RPT is reduced through pressure reducing valves, piping, and local flow measuring instrumentation. The LPPP Primary Purge System does not rely upon electrical power.

The LPPP Safety Grade Purge System, consisting of an ambient vaporizer and liquid nitrogen storage tank (located at the LPPP), provides a nitrogen source that initiates automatically in the event of loss of pressure in the LPPP Primary Purge System. Nitrogen to the vessels is reduced through redundant pressure reducing valves, piping, and local flow measuring instrumentation. Nitrogen gas may also be supplied from a vendor supplied tank truck and vaporizer at a connection in the nitrogen distribution piping.

The purge flow instrumentation, to the SPT, PPT, and RPT as well as the nitrogen supply inventory instrumentation provide post accident monitoring capabilities. In the event a tornado damages the backup nitrogen system, nitrogen bottles can be installed and connected to the chemical feed line to provide purge flow to the SPT and PPT. There is no emergency nitrogen bottle connection for the RPT. The LPPP Safety Grade Purge System does not rely upon electrical power.

CRANE AND CRANE OPERATOR STATION

The Low Point Pump Pit Crane is a bridge crane located within the LPPP building.

The LPPP Crane Operator Station is located on the west side of the LPPP. The concrete walls and roof along with the shielded viewing windows provide shielding for personnel within the room.

PUMP PIT VENTILATION SYSTEM

The Pump Pit Ventilation (PPV) system is provided at the LPPP to limit the release of radioactive materials, to control the atmosphere within the process tanks, and to limit radioactive particulate escape in the event of pit overpressurization. Outside air enters the cells after flowing through HEPA filters. The filters limit the possible release of radioactive particulates to the atmosphere in case of pit pressurization and backflow. Underground piping distributes the air to each cell. Air exits the pump cells and the sludge and recycle tanks to the surface-located ventilation equipment. A nitrogen flow through the SPT, PPT, and RPT prevents the buildup of a combustible composition with hydrogen. The exhaust vapors are then diluted by the large air vent stream. The pump tank and pit ventilation filtering equipment is adjacent to the pump pit building in a concrete-shielded enclosure with a rain cover.

DISTRIBUTED CONTROL SYSTEM

The Distributed Control System (DCS) controls the transfers between S and H areas. The DCS enables the DWPF production specialist to start and stop the equipment, adjust the process

control points, and perform other operations required for safe and efficient process control. The H-Area operator controls the transfer of sludge and HLW salt solution from the tank farm. Transfers from the LPPP and 512-S are controlled by S-Area operators.

5.3.2.9 512-S

The Actinide Removal Process (ARP) is mostly located in Building 512-S and designed to remove the solids from the Salt Solution by filtration.

The 512-S is comprised of the following buildings and support structures:

- 512-S, Process Building
- 512-1S, HEPA Filter Building
- 512-2S, Instrument Shelter Room
- 512-4S, Nitrogen Storage Pad
- 512-6S, Laboratory
- 512-7S, Cold Chemical Storage Area

The Process Building (512-S) is divided into a High Bay (Process Area) and a Low Bay (Service Area). The Process Area consists of a below grade structural concrete pit internally divided into three cells lined with stainless steel. The cells are capped with segmented reinforced concrete covers that can be removed and replaced remotely, using the bridge crane located in the High Bay. Equipment used to chemically treat and filter waste fed to the 512-S is located in the individual cells. The individual cells house equipment necessary for the chemical and filtration processes. Each of the three cells is equipped with a sump to collect leakage and spillage. A Backpulse Tank Vault is located at grade. The Service Area contains an Electrical Room, Battery Room, Change Room, offices, Crane Control Room, Vacuum Blower Room, and Instrument Control Valve Gallery.

Attached to the south end of Building 512-S is the Instrument Shelter (512-2S). The HEPA Filter Building (512-1S), which houses the Process Vessel Vent and Process Ventilation HEPA filter banks, is adjacent to 512-2S. A small laboratory (512-6S) is located to the East of the Process Building.

Located to the North of the Process building is the Nitrogen Storage Pad. The Cold Chemical Storage Area (512-7S), adjacent to the Nitrogen Storage Pad, provides a centralized location for the delivery, storage, and supply of cold feed chemicals to Building 512-S.

To support the process, the Filter Flush Water System provides for transfer of filter cleaning fluids in the amounts required for filter wet lay-up or chemical filter cleaning operations. The Process Vessel Vent System supplies fresh filtered air to the cells. Two air intake HEPA filters, one in service and the other in standby, mitigate the potential release of radioactive particulates in the event of a flow reversal from the cells to the environment.

512-S HOLD AND SALT PROCESSING TANKS

The Late Wash Precipitate Tank (LWPT) is used as a multipurpose reactor and filtration feed tank. Normally, MST/Salt Solution is transferred from the Tank Farm to the LWPT (the ability to add MST to the Salt Solution is maintained in 512-S as an off-normal evolution). The MST/Salt Solution is then circulated through the crossflow filtration unit to remove salt solution and concentrate the solids. Several batches of MST/Salt Solution are processed until the accumulated MST/Sludge Solids reach a slurry concentration suitable for transfer to DWPF. The MST/Sludge Solids may then be washed with water to reduce the sodium remaining in the concentrated slurry. After washing is complete, the slurry is transferred. If necessary, the filter is chemically cleaned after the washing operation is complete, and spent cleaning solutions are also transferred to the LPPP-PPT. These spent chemical solutions also function as a flush of the transfer line.

The filtrate produced during these operations will be collected in the Late Wash Hold Tank (LWHT), and later transferred to H-Area. In MCU, the Filtrate is treated as necessary to remove Cs-137 and then it is sent on to the Saltstone Facility for incorporation into grout.

Figure 5.3-4 depicts the ARP process in 512-S.

CRANE

The 512-S Crane is a 20 ton traveling bridge crane located within the building.

512-S PROCESS VESSEL VENTILATION SYSTEMS (PPV)

The 512-S Process Vessel Ventilation (PPV) System collects vented gases from the Late Wash Hold Tank (LWHT), Late Wash Precipitate Tank (LWPT), and the Surge Tank and combines these gases with dilution air from the Precipitate, Filter and Filtrate Cells. This combined vapor stream passes through a heater, a series of High Efficiency Particulate Air (HEPA) filters and an exhaust blower before passing through and out of the exhaust stack.

The 512-S PPV System also supplies fresh, filtered air to the Precipitate, Filter and Filtrate Cells. An air intake heater heats incoming air as required to prevent low cell temperatures. HEPA filters in the supply line limit the potential release of radioactive particulates in the event of a flow reversal from the cells to the environment.

DISTRIBUTED CONTROL SYSTEM

Operations are controlled using a Distributed Control System (DCS) from a DWPF Control Room. System operating parameters and alignments can be controlled and monitored remotely using the DCS. Local Control Stations (LCS) are also available to locally control and monitor system operating parameters and alignments. An Uninterruptible Power Supply (UPS) supplies power to critical DCS loads.

5.3.2.10 Failed Equipment Storage Vault Structure

The Failed Equipment Storage Vault (FESV) structure consists of reinforced concrete vaults, buried below grade. The FESV structure was designed as a Category I Facility. The north wall of FESV number 1 is also the south wall of FESV number 2. Each FESV is provided with a shield cover constructed of reinforced concrete and has four lifting trunnions. A weather cover is placed over the area where the two shield covers meet to keep rain water from entering the vaults. The weather cover is constructed of galvanized steel with gasket material attached to the underside. The FESV has a crane for removal of covers and for movement of the unusable radioactive equipment to be stored in the FESV.

5.3.2.11 Deleted

5.3.2.12 Swirl Cell Monitoring System

A swirl cell radiation monitor is located in the cooling water return line to detect any contamination that may have been picked up from services in the Vitrification Building. This cooling tower water swirl cell radiation monitor is located in the Service Building mechanical equipment room.

5.3.2.13 Mercury Storage Facility

The Mercury Storage Facility (MSF) is a stand alone building located west of Building 221-S. The facility is sized to store a 1-1/2 year production of mercury.

5.4 SERVICE AND UTILITY SYSTEMS

5.4.1 BUILDING VENTILATION

There are two basic types of ventilation systems in the DWPF facility. One system is designed for radiological areas, the other system is designed for clean areas. Ventilation zones are described in Subsection 5.4.1.1.

Ventilation systems for clean areas are designed to 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 radiological areas are designed to control the spread of airborne radioactivity 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 from a zone of low contamination potential to a zone of higher contamination potential. This type of ventilation system is provided for the Vitrification Building, portions of the Service Building, the Low Point Pump Pit, and 512-S. The ventilation systems for the Glass Waste Storage Building Vaults are designed for removal of the canisters decay heat.

5.4.1.1 Major Components and Operating Characteristics

The following paragraphs describe the individual ventilation systems for contaminated and noncontaminated air. Where appropriate, system components, collection and distribution systems, modes of air conditioning, filtration, filter protection, and air exhaust are described.

PROTECTIVE DEVICES

- Tornado damper or Tornado/Check Dampers. Duct penetrations through the maximum resistance structure envelope of the Vitrification Building (roof, freight elevator shaft, HVAC shaft, mezzanine, west wall, etc.) are equipped with tornado or tornado/check dampers. Tornado dampers are open during normal conditions and closed during the low-pressure conditions caused by a tornado. Tornado/check dampers are open when there is air flow and closes when there is no air flow. Where practical, air supply ducts are branched off inside the building to minimize the number of these dampers. The dampers are activated by tornado negative vortex pressure.
- Check damper**.** Duct penetrations to the CDC, the WTC, and the CDC-WTC canister transfer tunnel are equipped with check dampers to prevent any flow reversal of contaminated air to Zone 2 areas in case of duct leaks. The dampers are springloaded or counterweighted.
- Backdraft damper. Cell service room walls and the wall to the analytical laboratory areas are equipped with backdraft dampers to minimize migration of contamination into the corridors in the event of loss of negative pressure in the cells.

- Bypass inlet damper. Selected Zone 2 and Zone 3 supply systems are equipped with a bypass damper to allow makeup outdoor air to enter these systems. The dampers will also open on loss of normal (offsite) power.
- Isolation damper and fire detectors. Subsection 5.4.10 gives a description of the fire protection system.

VITRIFICATION BUILDING VENTILATION SYSTEMS

Supply air to the Vitrification Building comes from built-up HVAC air supply units. The air supply units and fans serving the Zone 1 areas and the weld test cell are located on the roof of Building 221-S. The air supply unit and fans serving the regulated machine shop and manipulator repair shop are located on the roof of the regulated machine shop. The air supply units and fans serving the second level clean areas are located on roof of the Service Building. The air handling units and fans serving the first and third level RBA corridors are located on the Service Building roof, the SCT decontamination and maintenance area roof, and the elevator loadout building roof. The units serving the electrical room (MCC and FOS) and the SCT maintenance area are located on the roof of Building 221-S.

The Zone 1 exhaust fans and auxiliaries are located in the fan house. The Zone 2 exhaust fans, Zone 2 main exhaust filter housing including HEPA and roughing filters, and exhaust stack are located on the roof of Building 221-S. The exhaust fans and filters for the weld test cell and for the various sampling and miscellaneous hoods are located inside Building 221-S.

The air supply units located outside the Vitrification Building have the following equipment:

- Storm louvers for the outside air intake.
- Filters to remove large dust particles.
- Moderate efficiency air filters.
- Preheat steam heating coils to heat the incoming outdoor air above freezing during the winter.
- Steam coils and chilled water coils to maintain desired temperatures.

Air supply units recirculating Zone 3 return air for Zone 2 supply have moderate efficiency air filters and chilled water coils. The chilled water and steam coils are arranged with manual shutoff valves so that a coil can be shut off without disturbing the rest of the system. Chilled water is supplied from chillers located in the Service Building.

Each air supply unit is equipped with two 100% capacity supply fans, except for the SCT decontamination and maintenance area that has one 100% capacity supply fan. The supply fans are equipped with variable inlet vanes, flow straighteners, and isolation dampers. Controls are supplied with the capability to start the standby fan when the operating fan develops operational problems that lead to a low flow condition.

VITRIFICATION BUILDING VENTILATION ZONES

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 includes the areas with the lowest potential for contamination. Therefore, the air pressure is maintained highly negative for Zone 1 and slightly negative for Zone 3. The areas contained in each zone are as follows:

Zone 1: Zone 1 includes the CPC, the SPC, the CMA, the CDC, the MC, the REDC, the Remote Process Cell Plenum (RPCP), the CDMC, the Railroad Well, the Analytical Cell, and the Sample and Mercury Purification Cells. The WTC is also characterized as Zone 1; however, it is maintained at slightly positive pressure relative to the remainder of Zone 1.

Zone 2: Zone 2 is subdivided into zones 2 and 2B. Zone 2 includes all normally occupied radiological areas with potential for contamination, such as the operating and service corridors on levels 1 and 3, all Regulated Shops (RSs), Manipulator Repair Shop (MRS), and the Railroad Well Air Lock. These areas are at a higher pressure than Zone 1 areas.

Zone 2B: Zone 2B is the operating space between Zone 2 and Zone 1 areas. This zone includes the analytical lab and sampling cell hoods, the mercury distillation hood and storage cabinet, and two cell entry/exit hoods. The pressure in these areas is less than that in Zone 2.

Zone 3: Zone 3 includes clean offices, FOSs 1 and 2, clean machine shops, clean equipment area, and other clean personnel areas on level 2. These areas are maintained at a positive pressure relative to areas in Zones 1, 2 and 2B. However, Zone 3 pressure is slightly below atmospheric outdoor pressure.

Zone 1 Supply and Exhaust Systems

Zone 1 processing cells are designed to be heated/cooled and ventilated with 100% outside air to limit the cell operating temperatures during the summer. Air is distributed to the various cell areas in accordance with ventilation requirements sufficient to remove equipment heat loads and to maintain design air velocities through open cell covers.

Four air supply units, each with two 100% capacity centrifugal-type fans, are provided for Zone 1 areas. The air supply units furnish air to the crane maintenance area, the chemical process cell, the remote equipment decon cell, the contact decon and maintenance cell, the canister decon cell, and the weld test cell. Supply fans are served by normal electrical power.

Air supply to the crane maintenance area and the contact decon and maintenance cell is provided by an air supply unit. The air supply flows to the crane maintenance and contact decon and maintenance cell and then to the remote process cells.

The remote process cells (chemical process cell, melt cell, and remote equipment decon cell) air supply is provided by an air supply unit, through the bus bar corridor and then to the air space above the cell covers. The total remote process cells' air supply includes infiltration from the

crane maintenance area, the canister decon cell, the contact decon and maintenance cell, the shield door hoist equipment room, and the railroad well.

The CDC air supply is provided by an air supply unit and fans. Some of the supply is discharged to the smear test area; the remainder is discharged to the canister decon area. Air supplied to the smear test station flows to the canister decon cell. Some air from the weld test cell flows to the canister decon cell through the canister transfer tunnel. A portion of the supply air flows to the melt cell through the canister transfer tunnel; some supply air flows to the remote process cells air space through designed slots in the cell covers.

The WTC is a direct contact maintenance area within the Zone 1 cell block that must be kept as clean as possible. It is, therefore, exhausted separately through the Zone 2 exhaust system.

The weld test cell air supply is provided by an air supply unit. The indoor environment is maintained to meet equipment operability requirements.

The supply duct penetrations to the Zone 1 cells are equipped with check dampers to prevent migration of contamination if the cells lose negative pressure. Dampers fail in the closed position.

Zone 1 air supply system control is provided with interlocked supply fans that shut down if the negative pressure in the sand filter inlet plenum rises above a set maximum. Controls are supplied with the capability to start the standby fan when the operating fan develops operational problems that lead to a low flow condition. Instrumentation is provided to measure the pressure inside each of the process cells relative to the atmosphere.

Three normally operating fans and one standby fan are provided to continuously exhaust air from the Zone 1 areas. Fans are located in the Building 292-S fan house. The building is designed such that, with the cell ventilation covers installed, air is drawn from the RPC plenum to the process cells below. Ventilation air from Zone 1 is drawn through the sand filter and then discharged to the atmosphere via the Zone 1 exhaust stack. The exhaust fans are equipped with variable inlet vanes, a flow measuring device, discharge dampers, and isolation dampers. Controls for the Zone 1 exhaust fans will start the standby fan when operational problems lead to a low flow condition or when the negative pressure in the exhaust rises above a set maximum pressure.

All fans shut down if normal power fails. The two 480 V load centers in the Fan House which serve the Zone 1 exhaust fans are connected to the two standby diesel generators. One out of four Zone 1 exhaust fans is required to operate to maintain the negative pressure needed. The fans are automatically switched to diesel power in the event of normal power failure.

An emergency exhaust port is installed on the duct between Building 292-S and the Zone 1 air exhaust stack. The damper can be manually opened if needed.

Air, which flows through the railroad well from the regulated shop air supply unit, is directed to the remote process cell air space. Exhaust from the process vessel ventilation system and the

off-gas vent system discharges into the Zone 1 exhaust tunnels for additional filtration at the sand filter.

Zone 2 Supply and Exhaust Systems

RBA corridors in the Vitrification Building levels 1 and 3, the SCT decontamination and maintenance area, the regulated machine and manipulator repair shops, and various shops are supplied with heated/cooled air to maintain an indoor environment consistent with equipment and personnel habitability requirements. Supply air to Zone 2 is provided by the following units.

Three air supply units and associated fans recirculate return air from level 2, Zone 3 clean areas, and supply air to levels 1, 3 and mezzanine Zone 2 RBA areas.

One air supply unit with two 100% capacity fans, supplies conditioned outside air to the manipulator repair shop, to the regulated shop, to the railroad well, and to the elevator machine room on the Vitrification Building roof.

One air handling unit supplies conditioned outside air to the SCT decontamination and maintenance area and to the records room. Supply air is exhausted through the canister load-out area to the Zone 2 exhaust system or directly outside via local exhausters.

Zone 2 air supply fans are normally interlocked off if the negative pressure in the Zone 2 exhaust plenum rises above a set pressure. Controls are supplied with the capability to start the standby fan when operational problems lead to a low flow condition.

The service corridors, regulated shops, and similarly occupied areas in the Vitrification Building are controlled areas that may become contaminated. The Zone 2 exhaust system, including HEPA filters and the exhaust stack, is described in Subsection 7.2.1.2.

Since there is potential for high contamination of the weld test cell, the exhaust from this cell is passed through HEPA filters before it enters the Zone 2 exhaust system for additional HEPA filtration before discharge to the atmosphere. Two 100% capacity HEPA filter trains are provided. They are located within a shielded room on the east mezzanine corridor. Each filter train consists of a stainless steel filter housing and frames, roughing filter bank, HEPA filter bank, a centrifugal exhaust fan, isolation dampers, and connecting duct work. The exhaust fans are equipped with variable inlet vanes, a flow straightener and measuring device, and isolation dampers.

Zone 3 Supply and Exhaust Systems

The Zone 3 areas inside the Vitrification Building level 2 are cooled and ventilated using 100% outdoor air supplied by three air supply units, each with two 100% capacity fans. The indoor environment is designed to meet equipment and personnel habitability requirements. Humidification is provided by local humidifiers where required. Return air is not recirculated to these areas. Instead, it is cascaded through air supply units and used as Zone 2 supply air.

Self-contained, backup air conditioning units are provided for FOS 1 and FOS 2. Cooling water is provided from the cooling tower under normal conditions or the emergency cooling water system in the event of normal power failure.

The electrical equipment room on the Vitrification Building roof is equipped with one ventilation unit. The indoor environment is maintained to meet equipment operability requirements.

Conditioned air is supplied to each of the two Battery Rooms by the Zone 3 air supply units. The battery rooms contain batteries for the 125 V DC power system and for uninterruptible power supplies. These batteries generate hydrogen gas during recharging. Sufficient air flow is provided to maintain a minimum air change rate to maintain the concentration of hydrogen in the battery rooms below the lower explosive limit.

The field operating station room on the Vitrification Building roof is equipped with a self-contained air conditioning unit and two standby air conditioning units on standby power. The indoor environment is maintained to meet equipment operability requirements.

Analytical Area Supply and Exhaust Systems

The analytical area consists of facilities on the west mezzanine including the laboratories, counting rooms, and the analytical, sample, and mercury purification cells. Ventilation zones for these facilities are classified as a combination of Zone 1 and Zone 2.

The analytical, sample, and mercury purification cells are small Zone 1 areas in which radioactive materials are handled. Air supplied to the cells is cascaded by fans from the corridors, through an inlet prefilter and HEPA filter, to the analytical, sample, and mercury purification cells. Exit air is directed to the Zone 1 exhaust tunnel. Laboratory (Zone 2) air is supplied by direct ducting from air supply units located on the SCT decontamination and maintenance area roof. The counting room receives air from a Zone 2 air supply system (located on the roof of the loading dock) and discharges to the Zone 2 exhaust system.

Mezzanine lab ventilation consists of 3 branches, each with its own HEPA filter housing. Exhaust air from entry/exit sample hoods serving mezzanine cells is one branch. Exhaust air from analytical hoods, radiobenches, and fume hoods in the analytical laboratory and the hoods in the organic laboratory is another branch. The third branch exhausts gas sampling hoods located on the mezzanine level. Each HEPA filter plenum consists of a stainless steel housing and frame, a prefilter bank, and the HEPA filter bank. Capability for filter replacement during operation is provided. Three exhaust fans are provided to direct mezzanine lab exhaust air to the Zone 2 exhaust system.

The canister smear test hood is located on the first level. This hood is exhausted through a local HEPA filter housing and exhaust fan before the air enters the Zone 2 main exhaust. The local HEPA filter housing consists of a prefilter bank and a HEPA filter bank.

SERVICE BUILDING RADIOLOGICAL HVAC SYSTEMS

The HVAC systems serving the radiological change areas and RC facilities located in the Service Building are designed to maintain area design temperature conditions during summer and winter operations. The once-through system supplies outdoor air. The air is exhausted to the Vitrification Building Zone 2 exhaust system. The HVAC equipment consists of an air supply unit and two supply fans, one operating and one on standby. Within the RBA areas, the RC laboratory and the instrument decontamination rooms are each provided with an exhaust hood. The air from these two hoods is exhausted to the Building 221-S Zone 2 exhaust system.

FILTER TESTING

HEPA filter housings are supplied with test sections on the upstream and downstream sides of the filter bank. Each test section is constructed in such a manner that adjoining test chambers are isolated from each other to permit individual testing of each HEPA filter section and its supporting framework in parallel and/or in series.

GLASS WASTE STORAGE BUILDINGS' VENTILATION SYSTEM

Canister Vault Ventilation

Canister vault ventilation is provided to remove radioactive decay heat from the storage vaults via the natural circulation of air. Outside air is drawn through the annular space between the stored waste canisters and the canister supports; it is discharged to the atmosphere.

Operating Area Ventilation Air

Operating area ventilation air is supplied to remove SCT diesel fumes and summer heat buildup. Four centrifugal fans with inlet filters supply outside air. Each fan is equipped with a discharge damper and intake housing louver. Gravity roof vents are provided for exhaust air relief. No provision is made for heating the operating area.

Inspection Gallery Ventilation (GWSB #1)

The inspection gallery is ventilated for cooling and contains electrical heaters. Electric roof exhausters with backdraft dampers are provided to induce ventilation air into the inspection gallery through intake louvers. Each intake louver is equipped with an automatic damper and two low efficiency filters.

Office Area and Electrical Equipment Room Ventilation

For GWSB #1, the office area and electrical equipment room are provided with heating and cooling units. An exhaust fan discharges air from selected portions of the office area through an 18-ft stack. A separate air conditioning unit and backup air handling unit is provided for the FOS room. For GWSB #2, the electrical equipment/FOS room is provided with a wall-mounted heating and cooling unit.

LOW POINT PUMP PIT VENTILATION SYSTEMS

Ventilation systems are provided for the maintenance enclosure, the FOS and crane control rooms, the electrical rooms, and the maintenance area of the Low Point Pump Pit (LPPP). During maintenance or abnormal occurrences, contamination may spread to the maintenance area, and HEPA filters are designed to clean the air before discharging it to the atmosphere through the stack. Details of the ventilation systems are discussed below.

Pump Pit Ventilation System

The Pump Pit Ventilation (PPV) system at the Low Point Pump Pit is provided to limit the release of radioactive material to the atmosphere within the criteria given in Section 7.1. The vent system exhausts through a heater and HEPA filters before release through the pump pit stack.

Low Point Pump Pit Maintenance Enclosure Ventilation

The LPPP maintenance enclosure, designed for intermittent occupancy, is provided with a ventilation system, which is supplied by outside air. The ventilating air is exhausted through a HEPA filter exhaust system that operates continuously when there are maintenance activities within the pump pit enclosure area. The ventilation air is discharged to a stack. The outside air is drawn through wall intake louvers with backdraft dampers and low efficiency filters.

Low Point Pump Pit FOS and Crane Control Rooms Ventilation

The FOS and crane control room are heated and cooled by an air conditioning unit designed to maintain temperatures to meet equipment operability and habitability requirements. The FOS room is provided with a backup unit.

512-S VENTILATION SYSTEMS

512-S Process Vessel Ventilation System

The 512-S Process Vessel Ventilation (PPV) system is provided to limit the release of radioactive material to the atmosphere within the criteria given in Section 7.1. The vent system exhausts through a heater and HEPA filters before release through the 512-S stack.

512-S Process Building Ventilation

The 512-S process building, designed for intermittent occupancy, is provided with a ventilation system that is supplied by 100% outside air. The outside air is drawn through eight wall intake louvers with backdraft dampers and low efficiency replaceable filters. The ventilating air is exhausted through a HEPA filter exhaust system and discharged to the 512-S stack. The backpulse tank enclosure is provided with a separate exhaust system to minimize the spread of contamination to the process building area. The backpulse tank enclosure exhaust system consists of an inlet HEPA filter, exit HEPA filter, and an exhaust fan which discharges into the process building.

When cell covers are removed during cell maintenance, the process building ventilation system is connected in parallel with the 512-S PPV system in order to divert process building air down into the cell. By establishing flow into the open cell, the potential for contamination in the process area is minimized.

512-S FOS and Crane Control Room Ventilation

The 512-S FOS and crane control rooms are heated and cooled by an air conditioning unit designed to maintain area design temperature and humidity during summer and winter conditions. The relative humidity of the FOS is maintained by a duct-mounted steam humidifier. The FOS room is provided with a backup unit.

512-S Electrical Rooms and Mechanical Areas Ventilation

Electrical rooms and mechanical areas are ventilated with 100% outside air by ventilation units. These areas are heated in winter by electric heating coils. Return/exhaust fans recirculate part of the room air.

The 512-S north electrical room is a closed-loop system in order to minimize dust and dirt in the room. Heating is provided by electric heating coils, and cooling provided by a fan and evaporator coil connected to an outside air-cooled condenser.

512-S Control Room Ventilation

The Control Room is heated and cooled by an air conditioning unit to maintain area design temperature conditions during summer and winter operations.

512-S Radiological Change Areas and Radiological Corridor Ventilation

The radiological change areas and radiological corridor are heated and cooled by an air conditioning unit to maintain area design temperature conditions during summer and winter operations. Air in the radiological corridor is exhausted to the process building to minimize the spread of contamination.

ELECTRICAL ROOMS AND MECHANICAL AREAS VENTILATION

Electrical rooms and mechanical areas are ventilated with outdoor air by rooftop ventilation units. The electrical rooms and mechanical area are heated by electric heating coils that are part of the units. Return/exhaust fans recirculate part of the room air.

WATER AND CHEMICAL WASTE TREATMENT BUILDING

The water and chemical waste treatment building is air conditioned and heated as necessary.

COLD CHEMICAL AND BULK FRIT STORAGE BUILDING

The Frit Tote Bin Area is provided with roof exhausters for ventilation.

The Slurry Preparation Area is provided with roof exhausters for ventilation. Electric heaters provide heating.

SERVICE BUILDING HVAC SYSTEMS

The following areas are heated, air conditioned, and/or ventilated as necessary:

- Chemical Storage Area
- Canister Storage Area
- Mechanical and Electrical Rooms
- Canister Inspection Area
- Computer Room, UPS Equipment Room, and Software Development Office
- Central Control Room, Supervisory Control Room, Remote Crane Control Room, Video Tape Storage Room, and RC Offices

DIESEL GENERATOR ROOM VENTILATION

The diesel generator rooms located in the Fan House are not ventilated. However, when the diesel generators are running, ventilation is provided by the engine radiator fans that draw outside air into the rooms. The engine radiator fans then exhaust the air from the building. In addition, each diesel room has two electrically powered unit heaters.

5.4.1.2 Building Ventilation Operability and Monitoring Considerations

To ensure the safety and operability of ventilation systems designed to handle air contaminated by radioactivity, or air with the potential for contamination, the systems are provided with backup equipment, standby power and testing, monitoring, and alarm capabilities as follows:

- Standby supply fans and isolation dampers are installed and are capable of assuming the function of any vital fan that may become inoperable.
- Parallel filtered exhaust paths are provided for Zone 2 in case one of the HEPA filter banks becomes plugged, and to facilitate filter changing.
- A standby exhaust fan is installed in each principal exhaust system. Controls are provided to start the standby fan when the pressure in the exhaust system increases above a preset limit.
- The Zone 1 exhaust stack is connected to the exhaust air duct. Standby electrical power is supplied automatically to the exhaust fan and the ventilation controls of each exhaust fan if normal power supply fails.
- Ventilation system components can be tested periodically for operability, efficiency, and required functional performance under conditions as close to design as practicable. These tests include the transfer to standby power and an ability to deliver flow and differential pressure for design conditions.

- Test ports are provided for HEPA filter inplace testing to ensure a leak-free seal and to detect deterioration of filter components.
- For monitoring and alarm capabilities, differential pressure indicators are provided between adjoining building zones of different contamination potential.
- Low differential pressure and low flow alarms are located in the analytical areas to indicate malfunction of the ventilation systems; alarms are provided in occupied areas and areas where radioactive material is handled.
- Differential pressure indicators are provided across each filter bank. High and low differential pressures actuate alarms or alerts.
- Pressure indicators (in the CCR) and auxiliary controls are provided for the exhaust fans.
- Instrumentation is provided for monitoring and controlling the liquid levels of the condensate sump and the condensate transfer line, and for measuring ventilation air flow in the sand filter exhaust tunnels.
- Gaseous effluents released to the atmosphere are monitored/sampled.
- The Zone-1 monitoring system measures radioactive particulates released to the environment. When the quantity of beta-gamma radiation emitted exceeds a preset level, a warning signal is activated in the CCR.
- The estimated annual release of radioactivity to the atmosphere as calculated from a curie balance is summarized in Chapter 7.

5.4.2 ELECTRICAL

The electrical systems supplying DWPF are coordinated to provide effective and reliable power for normal operation and the necessary degree of self-sufficiency to ensure safe operation.

5.4.2.1 Major Components and Operating Characteristics

ELECTRICAL POWER FROM OFFSITE

Offsite electrical power for the DWPF is supplied from the existing H-Area substation, which is part of the Savannah River Site power grid. The SRS grid is a system of substations and 115 kV transmission lines, coordinated to form a reliable electrical power system for the various SRS facilities.

The possibility of power failures or prolonged power outages due to faults in the grid is minimized by the following:

- The 115 kV substations and transmission lines are connected to form a loop system.
- Switching facilities at substations permit sectionalizing of transmission lines.
- With equipment and circuits in service, the grid can sustain the loss of a substation transformer or a 115 kV line or a 115 kV line section without causing a serious overload or interruption of essential service.

- The 115 kV grid is protected from lightning by static and ground wires and lightning arresters.

ELECTRICAL POWER FROM H-AREA

13.8 kV electrical power from H-Area is delivered over two 13.8 kV full capacity circuits connecting the H-Area switchgear to the DWPF switchgear. The feeder circuits consist of direct burial, armored jacketed cables installed in separate trenches.

Each H-Area feeder cable to DWPF is connected in DWPF to a separate 13.8 kV switchgear bus through incoming main breakers. A normally closed tie-breaker in S-Area connects these two buses to each other and allows either feeder to supply both buses. The H-Area substation busing and switching arrangement permits isolation of 115 kV lines, main transformers, and the 13.8 kV switchgear bus so that a single failure of that equipment will not result in an outage or curtailment of service to S-Area. The switching arrangement also allows for maintenance of the H-Area equipment without curtailing production.

The 13.8 kV switchgear control circuits in DWPF operate from 125 V DC power supported by batteries.

The 512-S has a separate 13.8 kV feeder also coming from H-Area. It is an armored, jacketed set of cables in an underground duct bank connected to a pad-mounted substation transformer located in the northwest corner of the facility.

SECONDARY SUBSTATIONS

Secondary substations transform voltage from 13.8 kV to 480VAC; they consist of switching and protective equipment for supplying and distributing electrical power to S-Area. To preserve the redundant character of the primary system, each secondary substation is connected to the two 13.8 kV primary buses through a redundant distribution system consisting of 13.8 kV circuit breakers, 13.8 kV cables, and duplex 13.8 kV interrupter switches at the substations for selecting one or the other 13.8 kV feeders. Each 13.8 kV feeder circuit is sized to carry the full substation loads. The secondary substations are also known as load centers.

Each substation power distribution system uses a standard selective tripping scheme, coordinated to limit the effects of a system fault and to isolate the affected portion of the system. The 13.8 kV substation power supply breakers may be equipped with an instantaneous overcurrent selector switch that enables the instantaneous protective feature of the overcurrent relays. Enabling the instantaneous portion of the protective relays defeats the selective coordination present when only using the timed overcurrent portion of the relay. The instantaneous feature is used to enhance worker safety by reducing the potential arc flash at the supplied secondary substation. This feature could trip a 13.8 kV supply breaker (and subsequent loss of the supplied secondary substation) instead of clearing a fault closer to the source.

Most secondary substation switchgear control circuits operate from 125 V DC power supported by batteries located in close proximity to the 480 V switchgear.

Two substations are used to distribute standby power. These substations are automatically connected to the onsite standby diesel generators when normal power is lost.

The 512-S substation transformer, also 13.8 kV to 480 V, feeds the motor control centers via underground duct bank.

STANDBY POWER SUPPLY

Standby electrical generation facilities are provided to maintain power to essential loads and services when normal power is not available. The standby power facilities include two systems. Each system is equipped with a diesel generator unit and auxiliary equipment, including a fuel storage and transfer system, instrumentation, controls, indication, and annunciation. The diesel generators are located in the Fan House.

A loss of normal power will result in undervoltage at load centers B9 and B10, which will open their respective normal power breakers (B9-2B and B10-2B) and send a start signal to the diesel generators. Diesel Generators DG100 and DG200 are then connected to Load Centers B9 and B10 respectively.

Each diesel generator has a continuous rating of 2,000 kW, 0.8 pf, three-phase, 60 Hz, 480 V. Each diesel has a 450-gallon day tank. Refilling of the day tank by a transfer pump in either of two redundant underground storage tanks is provided. The two underground storage tanks are 15,000 gallons each and are located west of the Fan House. These two tanks are common to both diesel generators. The diesel generators are capable of maintaining a voltage of not less than 80% and a frequency of not less than 95% of nominal throughout the duration of loading.

UNINTERRUPTIBLE POWER SUPPLIES

The Uninterruptible Power Supplies (UPS) provide a highly reliable source of (electric) AC power to equipment, controls (including DCS), and instrumentation that would be adversely impacted by a momentary loss of power. The UPS configuration ensures the continuity of output power through the use of batteries and through the use of two input AC power sources (primary and secondary) except for the UPS at GWSB #2. The UPS at GWSB #2 has batteries and has one input AC power source.

The UPS modules can be bypassed completely, thus allowing maintenance to be performed on the modules while the loads remain energized. Operation of the bypass switches is administratively controlled.

125 V DC BATTERY SUPPLIES

DC systems utilize batteries and battery chargers to supply DC loads at DWPF. These loads include switchgear and load center circuit breaker control power, diesel generator control power, annunciators, and instrumentation.

Normal DC power is supplied from the battery charger, which is sized based on the system load requirements. Upon loss of AC power to the charger, the loads are supplied from the battery

bank. When AC power is restored, the battery charger supplies the loads while also recharging the batteries.

LIGHTNING PROTECTION SYSTEMS

DWPF utilizes a Dissipation Array System on various structures to improve the overall lightning protection system. The system consists of large umbrella-type structures and grouped overhead parallel wires. The system is designed to continuously produce and bleed off charged ions in the vicinity, with the intent of reducing the potential to a value less than required to produce a lightning strike.

This supplemental lightning protection system has been installed on or provides coverage for the following structures:

- Service Building
- Vitrification Building
- Glass Waste Storage Buildings
- Fan House Building and Exhaust Stack
- Water Treatment Building
- Organic Waste Storage Tank (not in use)
- Operations Building
- Low Point Pump Pit
- Cooling Tower
- Primary Substation

Conventional lightning protection has been provided for 512-S.

5.4.2.2 Electrical Operability Considerations

Major features of the electrical system, which enhance its reliability, are summarized in this subsection. Exceptions to some items may exist where analysis shows that omission would not degrade the system below acceptable levels.

Site standby diesel generators and an offsite electrical power source provide power to the various plant structures, systems, and components. The function of each system is to provide, under normal conditions, the capability to ensure that:

- The potential release of radioactive material to the environment is restricted to below acceptable limits.
- Process systems are maintained in a condition as required to perform safety functions.

- The onsite power supplies, including batteries, standby diesel generators, and the onsite distribution system, have sufficient independence, redundancy, and testability to perform those functions identified as being safety related.
- Electric power from the SRS transmission network is supplied to the DWPF electric distribution system by two redundant circuits, designed to minimize the likelihood of their simultaneous failure under operating conditions. Both circuits are normally energized, and each circuit is rated to carry the maximum DWPF load. 512-S is supplied by a separate circuit tied to the SRS network.
- Pilot Wire Cabinets are included to minimize the probability of losing both feeder lines as a result of a fault on one of the feeder lines.
- To assess continuity and the condition of their components, electrical power systems are designed to permit periodic inspection and testing of important components and features.
- Electrical apparatus is sized on the basis of the most severe load demand, either continuous or intermittent, and adverse environmental conditions.
- Power transformers are sized for the largest combination of continuous loads plus an allowance for short time or intermittent loads.
- Special attention is given to the selection of motor insulation to ensure compatibility with service requirements, environment, and other factors.
- A major objective of the physical arrangement of dual, redundant, essential equipment is to minimize the possibility of a single design basis event disabling both systems.

5.4.3 COMPRESSED AIR

Compressed air services provided include plant, instrument, decontamination, and breathing air.

The Vitrification Building plant/instrument air system 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.

Two redundant plant/instrument air compressors are connected to standby diesel electrical power feeds in the event normal power is lost. Non-critical plant air users can be isolated so that instrument and critical plant air services can be supplied from a single compressor. Cooling water is supplied to the operating compressor. Instrument air is provided to the following facilities:

- Glass Waste Storage Building #1
- Sand Filter
- Fan House
- Service Building
- Cold Chemical and Bulk Frit Storage Facilities

- Water and Chemical Waste Treatment Facilities
- Cooling Water and Auxiliary Facilities
- Vitrification Building
- Low Point Pump Pit

512-S instrument air is supplied directly from H-Area.

The breathing air system provides air to breathing air stations located in the Vitrification Building and 422-S and 980-S areas. High pressure breathing air cylinders in the Vitrification Building provide emergency backup for the breathing air system. Breathing air for other area locations can be provided by portable cylinders or a portable breathing air compressor.

The canister decontamination air system provides air to the Canister Decontamination System, the CO_2 Blasting units, and REDC miscellaneous air supply.

5.4.4 STEAM SUPPLY AND DISTRIBUTION

DWPF steam is supplied by an interarea line from H-Area at a normal operating range of 260 - 300 psig for building and process heating and the operation of auxiliary equipment. The line branches and supplies the 512-S, the Low Point Pump Pit, Building 980-S water treatment facility, Building 210-S, and Building 221-S.

5.4.4.1 Steam Distribution Systems

Closed loop process condensate is cooled, collected in a hold tank and recycled to a steam generator. High pressure steam is used in the steam generator located on the first level in Building 221-S to vaporize closed loop condensate into closed loop process steam.

Closed loop process steam is delivered to the following process cell vessels:

- Sludge Receipt and Adjustment Tank (SRAT)
- Slurry Mix Evaporator (SME)
- Decontamination Waste Treatment Tank (DWTT)

The closed loop system ensures isolation of radioactive contamination in case of a coil leak and depressurization.

Medium pressure steam is delivered to Building 221-S where it is used for decontamination in the crane maintenance area, the REDC and the CDMC.

Open loop process steam is supplied to the primary and backup film coolers and the melter borescopes on the melter vessel, the CDMC and REDC gang valves, and the first and second stage scrubbers on the primary and backup off-gas systems.

Low-pressure steam is used for HVAC services, including supply to heating coils and steam humidifiers. Low pressure steam is also used to supply the heating coils in the oxalic acid, sodium nitrite, boric acid and decon solution makeup tanks, and the caustic tank.

At the Low Point Pump Pit, the steam is reduced to approximately 120 psig and supplied to a header and is further reduced to approximately 15 psig.

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

5.4.4.2 Steam Condensate System

Three condensate systems, one from the high pressure steam supply, one from the medium pressure steam supply, and the other from the low pressure steam supply, handle condensate from nonradioactive users. In addition, condensate from humidifiers in 221-S is collected in the condensate collection tank and pumped via a sump to the floor drain collection systems. Condensate from some humidifiers also drains into the steam condensate heat recovery system.

Medium and high pressure condensate is piped to 422-S where it is allowed to flash to low pressure steam in a flash tank. This steam is piped to the low-pressure steam supply header and the condensate is sent to the clean condensate tank.

Condensate from the heating coils in HVAC units on the 221-S and 210-S roofs is pumped to the heat recovery heat exchanger where the remaining usable heat in the condensate is transferred to a hot water heating system. The hot water system supplies heating coils in some HVAC units for 210-S.

Condensate from the heating and ventilation systems and nonradioactive process users is used as process water for cold chemical makeup and other process users.

5.4.5 WATER SUPPLY

The water supply is composed of:

- Supply water wells.
- Distribution lines from the wells to the water treatment and storage area.
- Backup cooling water (raw well water) to the melter cooling water heat exchangers and process cooling water heat exchangers, plant/instrument compressors, breathing and canister decon air compressors, process chilled water system, central control/computer room chiller cooling system and various other users.
- Water treatment and storage facilities.
- Domestic water supply lines.
- Neutralized and fire water supply lines.
- Backup fire water from H-Area.

5.4.5.1 Water Wells

Water is supplied to the DWPF (excluding the 512-S) from two wells located in DWPF. The pumps are set at approximately 250 ft below grade. A combination electric and diesel-driven pump is provided for each well.

5.4.5.2 Water Treatment and Storage Facilities

The water treatment and storage area consists of a degasifier system, a pH adjustment system for water treatment in 980-S, and a neutralized/fire water storage tank.

The high CO_2 content in the well water at the SRS gives it a low pH and a corrosive quality. An elevated degasifier is provided to reduce the CO_2 concentration. The degasifier is elevated to provide discharge to the storage tank by gravity flow.

The pH of the degasified well water is adjusted. This treated water supplies neutralized water to the neutralized/fire water storage tank. Neutralized (nonchlorinated) water is supplied to selected users where the chloride ion constitutes a chemical contaminant or a potential cause of stress corrosion cracking in stainless steel equipment or piping.

A Water and Chemical Waste Treatment Building houses facilities for water analysis and control, for unloading and storing of treatment chemicals, for water treatment systems, for neutralized distribution pumps, fire pumps, and an electrical room.

A combination neutralized well water/fire water storage tank with a capacity of 300,000 gallons is located outside the fire pump rooms on the south side of the water treatment building. The bottom 240,000 gallons of the tank are reserved for fire protection and cannot be accessed by the neutralized well water distribution system.

Neutralized water pumps are connected to standby power. Water for emergency showers and eyewash stations is supplied by the domestic water system.

The 512-S provided domestic water from the H-Area domestic water header through underground and above ground piping.

5.4.5.3 Water Supply Lines

The water supply lines include the distribution lines from the water wells to the water treatment and storage area, the backup cooling water for the melter and process cooling systems, the plant/instrument air compressors, and the process chilled water cooling systems. Water supply lines also include the domestic and neutralized/fire water supply lines, cooling tower water makeup lines, and process water storage backup supply lines.

The domestic water system supplies water for drinking and sanitary purposes and/or emergency shower and eyewash stations from the site domestic water system to the following facilities:

- Service Building.
- Vitrification Building.
- Glass Waste Storage Building #1.
- Fan House.
- Bulk frit and miscellaneous cold feed storage facilities.
- Low Point Pump Pit.
- Operations Building.
- Sanitary sewers and sewage treatment facilities.
- Primary and secondary substations and auxiliary facilities.
- Cooling tower and auxiliary facilities.

Under no circumstances is the domestic water system physically connected to a potentially contaminated system.

The neutralized water system supplies makeup water to the cooling tower and to the process water system.

In 512-S, domestic water is used for eye wash stations, safety showers, laboratory purposes, drinking and sanitary purposes, and hose bibs. Domestic water supplies the process water system through backflow preventers. Domestic water also supplies the Wash Water Treatment and Storage Tank.

Domestic water supplied to the Wash Water Treatment and Storage Tank is pH adjusted, when needed, and stored in 512-S. The wash water is used for cell sprays, tank sprays (flush water), and supplying the wash water header for subsequent feed to the LWPT during MST/Sludge Solids washing.

Domestic water is also provided through backflow preventers to provide deionized process water to make up diluted caustic solutions in the Caustic Mix Tank and for flushing cold chemical storage tanks. This water is also pH adjusted, when needed, and delivered to the Backpulse Tank and Surge Tank for crossflow filter flushing, cleaning, and lay up.

5.4.6 COOLING/CHILLED WATER

5.4.6.1 Major Components and Operating Characteristics

The following cooling water systems are provided:

- Melter cooling water systems.
- Process cooling water system.
- Process chilled water system.

- HVAC chilled water system (CCR, computer room, analytical facilities).
- Cooling tower water system.

MELTER COOLING WATER SYSTEM

The melter cooling water system is used to cool the melter shell to reduce the temperature of its outside surface. The melter cooling water system includes two heat exchangers, two circulating pumps, and a piping system to the melter and off-gas system. One heat exchanger and one circulating pump are capable of cooling the melter shell. 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. Contaminated water is handled with a bleed and feed process. Contaminated water is bled off and transferred to the backup off-gas condensate tank while clean water is fed into the system for dilution purposes. Contamination may also be removed by a portable deionizer or filter.

The cooling tower water side of the heat exchangers is designed to operate at a greater pressure than the melter cooling water side in order to prevent potentially contaminated water from leaking into the cooling tower system.

PROCESS COOLING WATER SYSTEM

The process 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 maintaining temperatures of various process solutions in required ranges. A closed loop cooling water system is used to ensure confinement of radioactive material in the event of a leak into the cooling water from the process equipment being cooled.

The process cooling water system includes two heat exchangers, two circulating pumps, and a closed loop piping system to the process equipment to be cooled. Heat is transferred from the heat exchangers to the cooling tower water system. Return cooling water from the process equipment is monitored for radioactive contamination. Contaminated water may be transferred to the recycle collection tank, and minor radioactivity may be removed by a portable deionizer or filter.

The system is designed to operate at a positive pressure so that leaks will be maintained in the system (i.e., any leakage will be into the process equipment rather than into the cooling water system).

PROCESS CHILLED WATER SYSTEM

The process chilled water system provides cooling water to the melter off-gas system, formic acid vent condenser, and GC sample coolers. The system includes two water-cooled chillers and two chilled water circulating pumps. Return chilled water from the process equipment is monitored for radioactive contamination.

Contaminated water may be transferred to the recycle collection tank.

The system is designed to operate at a positive pressure so that leaks will be maintained in the system (i.e., any leakage will be into the process equipment rather than into the chilled water system).

The 512-S uses a Process Chilled Water System to cool the contents of the LWPT.

HVAC CHILLED WATER SYSTEM

The HVAC chilled water system provides cooling for air conditioning of the Vitrification Building, Service Building, and analytical facilities. No process cooling loads are connected to this system.

COOLING TOWER WATER SYSTEM

The cooling tower water system provides cooling water for the process, air compressors, HVAC chillers, and other nonprocess equipment. Cooling for the process is through heat exchangers in closed loop cooling water systems to isolate the cooling tower water from cooling water circulating through process equipment.

The cooling tower water system comprises one induced draft, standard crossflow cooling tower with sprinklers and equipped with four circulating water pumps. Wet pits are provided for the cooling tower circulating pumps. Neutralized water is used as makeup for the cooling tower. Blowdown from the cooling tower is discharged per Chapter 7, Section 7.3.2.

The chemical treatment of the cooling tower water system comprises the following additions:

Biocide

Cooling tower basin water is treated with biocide to control biological growth in the tower and basin.

Corrosion Inhibitor

The circulating water is fed with a water treatment chemical to inhibit corrosion and scaling.

Equipment required for the chemical treatment of the cooling tower water system is housed in the chemical treatment facility, which is adjacent to the cooling tower.

5.4.6.2 Cooling Water Operability and Monitoring Considerations

The cooling tower water system is connected to the raw well water system to provide a backup source of cooling water for the melter cooling system, process cooling water system, process chilled water system, and instrument/plant air compressors.

The melter cooling water system, the process cooling water system, the process chilled water system, and the cooling tower water return are monitored for radioactivity. Provisions are made for diverting contaminated water to the backup off-gas condensate tank/recycle collection tank.

Flow, pressure, and temperature measuring devices are provided to monitor the cooling water systems.

Standby electrical power is provided for the melter cooling water pumps, the process cooling water pumps, and the process chilled water pumps and chillers. Standby electrical power is also provided for the control room/computer room chillers.

Subsection 5.4.10 gives a description of the fire protection system.

5.4.7 SEWAGE TREATMENT

Sewage treatment at DWPF consists of a lift station, which transfers sewage waste to the Central Sanitary Wastewater Treatment Facility. No sanitary water treatment is performed at the DWPF.

5.4.8 CHEMICAL AND INDUSTRIAL WASTE TREATMENT

Chapter 7 gives a description of chemical and industrial waste treatment.

5.4.9 COMMUNICATIONS AND ALARMS

The DWPF communications and alarm networks are designed to provide effective and reliable communications between various plant locations within DWPF, and interconnections with other SRS areas 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.

The communications network includes the following major systems:

- System telephone extension into DWPF – The existing SRS telephone network extends into DWPF, and it is integrated with the DWPF system, including the 512-S.
- Plant SST telephones.
- Public address system speakers are strategically located throughout the area to ensure that vital information reaches personnel. This system is normally used for operating, maintenance, and paging.

The alarm systems include:

- Fire alarm system – Subsection 5.4.10 gives a general description of the fire alarm system.

- Plant operational alarms system – This system includes radiation alarms for high airborne radioactivity concentrations in building air and associated ventilation systems (Subsection 5.4.1), alarms for high radioactive material concentrations in site liquid and gaseous effluents (Subsection 5.2.3), and central instrument control operations alarms (Subsection 5.2.3) for equipment.

The communications and alarm systems are provided for safe operation, and they may be needed to mitigate accidents or adverse conditions. The unique design and configuration of the DWPF are considered in the selection, placement, and spacing of communications and alarm devices. The communications and alarm systems of this facility are conventional types, with a history of successful operation at existing installations. The communications systems are in routine use, which is a means of self-monitoring that provides additional assurance of their availability for emergencies. The alarm systems are infrequently used, and they are, therefore, periodically tested.

The design and application of the public address and communication equipment ensures its suitability for the ambient noise levels that are expected in the areas used during normal and emergency conditions. This equipment meets OSHA requirements.

The following features are incorporated in the design.

- Conditions considered important to plant objectives are alarmed in the continuously occupied CCR.
- The radiation monitoring system alarms are located near the monitoring point as well as at the LCS. Radiation monitor alarms that require Operations action are routed to the CCR.
- Subsection 5.4.10 gives a description of the fire protection system.
- The site-wide communications and alarm systems are supplied by diesel generators or are UPS powered with enough battery capacity to maintain the systems until diesel generators are moved into place and connected.
- Separate raceways are provided for the various telephone systems, the public address and intercom systems, the safety alert system, and the fire alarm system.

5.4.10 FIRE PROTECTION SYSTEM

5.4.10.1 Design Basis

The fire protection system for the DWPF is based on DOE Directives on fire protection, improved risk criteria, National Fire Codes (NFPA Codes), Model Building Codes and guidelines from nationally accredited testing facilities such as Underwriters' Laboratories (UL) and Factory Mutual (FM) Engineering Corporation. Its purpose is to detect fires and to contain, suppress, and extinguish fires to protect personnel, the general public and the environment and to limit damage.

5.4.10.2 Fire Protection Program Basis

The fire protection systems at DWPF are based on DOE directives and improved risk criteria to control and extinguish fires and to limit the extent of fire damage. The DWPF fire protection systems include

- Fire Suppression System
- Fire Detection and Alarm System
- Water Supply and Distribution System
- Standpipe, and Fire Hydrants
- Portable Fire Extinguishers
- Manual Pull Stations
- Exterior Fire Exposure Protection
- Compartmentalizing with Fire-Rated Boundaries
- Fire Barrier Wrapping

FACILITY FIRE PROTECTION BASIS

The DWPF fire protection features for the main project (S-1780) were based on guidance from DOE Orders 5480.7 and 6430.1, audit recommendations, and DWPF special provisions to increase the total investment protection. The maximum possible property losses from fire as defined in DOE Orders 5480.7 and 6430.1 were modified for the DWPF project from $10,000,000 per fire event and a six-month program delay to $1,000,000 per fire event and a three-month program delay. Subsequent projects and modifications to provide fire protection enhancements at the DWPF are based on SRIDs (Ref. 36) DOE Orders 5480.8A and 5700.6B, applicable NFPA codes (including Life Safety Codes), F-PRP-G-00001 (Savannah River Remediation Fire Protection Program Plan) (Ref. 63), and Manual 2Q (Ref. 25) fire protection program manual. Manual 2Q is a living document that will be updated on a regular basis to incorporate revisions in applicable DOE Orders and referenced standards. The requirements within this manual establish a base from which to implement a comprehensive fire prevention and loss control management program.

5.4.10.3 Applicable Codes and Standards

The codes and standards related to fire protection that are in effect when facility design commences (code of record) remain in effect for the life of the facility. Modifications of a substantial nature, as determined by the Authority Having Jurisdiction (AHJ), are designed to the current edition of an applicable code. DWPF design was begun before DOE Order 6430.1 was issued and construction was essentially complete before DOE Order 6430.1A was issued. Table 5.4-2 provides the code of record or references in which this can be found.

Per DOE Order 6430.1A, the Standard Building Code will be the building code of record for the Savannah River Site for those issues not specifically addressed as part of another code or

standard. The Uniform Building Code (UBC) will be the defining authority for the definitions of fire resistance ratings and types of construction.

EXCEPTION: If there is a significant hazard that endangers building occupants or the public, as determined by the AHJ, the upgrade shall meet the requirements of the current edition of the code or standard.

5.4.10.4 Fire Protection Features

Essential elements of the Fire Protection program at DWPF are the passive and active fire protection systems.

- Passive system components which provide fire prevention, confinement, and damage limitation and life safety features in the design of the plant structures and systems.
- Active system components, generally recognized as fire protection systems, which include fire detection, suppression, and control systems and equipment.

The DWPF buildings/facilities have been evaluated by the Fire Hazard Analyses listed in Table 5.4-1.

5.4.10.5 Passive Fire Protection Systems

Fire prevention is achieved in the design of the plant through the provision of features that reduce the incidence of fires and limit the property loss, injuries and impact on the environment due to fires. Features include plant arrangement, building and structural design (including fire barriers), construction material, penetration seals, drainage, ventilation systems, emergency lighting, and provision of egress.

FACILITY CONSTRUCTION

Buildings at DWPF are generally constructed of noncombustible materials. Construction of bearing walls, columns, floors and roofs are either steel or steel reinforced concrete. Construction classification of buildings at the DWPF are described in the Fire Hazard Analysis for each building (see Table 5.4-1).

Structural steel is unprotected from fire damage. The Vitrification Building has the structural members embedded in reinforced concrete.

FIRE BARRIERS

Fire areas are isolated from each other by floors, walls, and ceilings having fire resistance ratings. Exterior buildings, walls, and roofs are of heavy concrete construction or insulated metal siding, and generally are shown as "Unrated" fire boundaries on the fire protection and safety zone drawings or on fire control preplans.

Stairwells in the vitrification buildings are located in concrete shafts having fire ratings as required by the NFPA Life Safety Code and are provided with self-closing fire doors. These stairwells are not pressurized.

FIRE DOORS

Door assemblies through fire barriers have fire ratings commensurate with those required of a fire barrier, except where equivalencies or exemptions exist. The doors are self-closing or the automatic-closing types. Some door openings are designed to handle higher than normal pressure loads, to provide missile resistance and radiation shielding, and to meet the combined requirements of pressure and missile resistance. These doors were specially designed to meet the DWPF criteria and have Certificates of Conformance from the manufacturer.

OTHER OPENINGS

The shielded viewing windows for the remote process cells, such as sample and analytical cells, mercury purification cells, etc. are not "listed" or "labeled". These shielded viewing windows are of unique construction. Mineral oil between thick glasses provides enhanced viewing characteristics. A fire hazard analysis indicated that the shielded viewing windows do not pose any significant impairment to fire protection. The Factory Mutual Test Report (Ref. 27) concludes that the shielded viewing windows withstood the 3 hr time-temperature exposures as specified by ASTM E-119 and UL 1709 and met the acceptance criteria.

PENETRATIONS THROUGH FIRE BOUNDARIES

Penetration sealing systems used for piping penetrations through fire barriers provide both necessary piping flexibility and containment of smoke and flames. They may use non-combustible piping, boots, sleeves, and sealants in accepted combinations. Cable, cable trays, conduits, and piping penetrations at fire barriers are sealed to give (at a minimum) the same hourly rating as that of the fire barrier.

Penetration openings through fire area boundary barriers for ventilation systems are protected by fire dampers except where equivalencies or exemptions exist.

MEANS OF EGRESS

Adequate means of personnel access and egress are provided for each fire area, except where equivalencies or exemptions exist and are suitably marked and emergency lighted to permit escape of occupants and entry of fire response and operations personnel.

In the event of a power loss, the essential lighting systems provide additional illumination.

Stairwells in the Vitrification Building are located in concrete shafts having fire ratings as required by the NFPA Life Safety Code, and they are provided with self-closing fire doors. Fire exit routes are clearly marked. Other stairwells comply with NFPA 101 except where exemptions exist as analyzed by the fire hazard analyses listed in Table 5.4-1.

CONTROL OF LIQUID RUNOFF

A 1200-gallon organic acid drain collection tank is located in Building 221-S at the tunnel level. This tank will collect organic liquid, which has the potential of being flammable/combustible, from any inadvertent spill or maintenance activity associated with the Building 221-S third level tanks.

Facility buildings in or near areas that contain sprinklers, or standpipe or fire department connections have floor drains installed where required for liquid runoff control. Dikes, along with drainage, are provided where needed to contain spill and fire-fighting water. Water removal in other areas is provided by the normal drainage systems where contamination spread is not a concern.

PRODUCTS OF COMBUSTION

Portable electric smoke removal fans (carried by fire department personnel) are provided to facilitate fire fighting and may be used to direct smoke to areas that are served by functioning portions of the exhaust system. These fans, designed specifically for smoke removal, operate on normal AC power. In the event normal AC power is not available, portable gasoline-powered generators are also available.

The fresh air supply intakes are physically separated from exhaust air outlets to minimize the possibility of exhaust air being drawn into the supply intakes and contaminating the intake air with the products of combustion in case of fire.

Stairwells are designed to minimize smoke infiltration during a fire by the provision of fire doors.

ELECTRICAL CABLE FIRE PROTECTION

Generally, wiring running outside of cable trays is enclosed in metallic conduit to reduce the exposure of the cable to hazards.

Other wiring may be installed either in short runs of flexible nonmetallic conduit or otherwise installed in accordance with Technical Work Documents and is subject to the facility procedure for control of flammables and combustibles.

Cable tray construction materials are noncombustible. Cable trays and conduit are used for cables only. Miscellaneous storage is not permitted in cable trays, raceways, trenches, or culverts.

The cable tray servicing Diesel Generator DG 200 is routed through the room that houses Diesel Generator DG 100 and is protected from fire by a two hour rated fire wrap.

Fire protection of areas containing dense cable trays is achieved by design of the facility with the following:

- For early warning of fires in the electrical cables, smoke detectors are provided for the cable trays, and/or
- For control and minimization of fire effects in areas of dense cable trays, automatic over-tray wet pipe sprinkler systems are provided.

5.4.10.6 Active Fire Protection Systems

DWPF Active Fire Protection Systems are:

- Water supply and distribution system including the fire water tank, fire pumps, yard and interior distribution piping.
- Automatic suppression systems including Halon systems and sprinkler systems.
- Fire detection systems for the detection of fire, automatic suppression system actuation, fire protection equipment supervision and signaling.
- Manual fire response equipment such as portable fire extinguishers, halon system, water spray, breathing equipment, emergency use of the plant communication equipment, and emergency lighting.

512-S Active Fire Protection Systems are:

- Dry pipe sprinkler system in 512-S electrical rooms, clean change rooms, RC area, offices, control room, FOS room, and valve gallery.
- Wet pipe sprinkler system in 512-6S Laboratory.

5.4.10.7 Water Supply and Distribution System and Special Fire Suppression Systems

FIRE WATER STORAGE TANK

A 300,000-gal storage tank is used for neutralized well water storage. The bottom section (240,000 gal) of the tank is dedicated to fire protection. A connection is provided to supply water to the fire department pumper truck, if required.

The fire water storage capacity is based on a fire water pump flow for a duration of 2 hrs. The fire pumps are sized based upon the highest sprinkler system demand.

There is an alternate fire water supply from the H-Area yard loop that feeds the DWPF yard loop through a normally closed valve in the southwest corner of the DWPF.

The DWPF fire water loop can supply fire water to SWPF.

The fire water supply to the 512-S is from the H-Area loop.

ELECTRIC MOTOR-DRIVEN FIRE PROTECTION WATER PUMP

The primary fire pump is driven by an electrical motor. The pump is capable of supplying sufficient flow and pressure for the largest sprinkler system demand. The pump has a pressure switch for automatic starting. An alarm indicates when the pump is running.

DIESEL ENGINE-DRIVEN FIRE PROTECTION WATER PUMP

The redundant fire pump is diesel engine driven. This pump has a pressure switch for automatic starting if the electric pump is unable to maintain system pressure.

FIRE WATER JOCKEY PUMP

The fire protection water system piping is kept pressurized by a jockey pump to prevent the unnecessary start of the fire protection water pumps.

UNDERGROUND PIPE MAIN LOOP

The fire protection water main consists primarily of an underground pipe main loop. Fire water and/or fire hydrants are supplied for each building. The loop contains post indicator valves, allowing individual sections to be isolated for repairs or maintenance.

Fire hydrants are of the cast iron dry-barrel type. Key operated curb box valves are installed ahead of each hydrant to permit maintenance or repair without shutting down the rest of the loop.

STANDPIPE SYSTEM

Wet standpipes are installed in the Vitrification Building 221-S to supply fire department connections at specific fire hazards locations and associated equipment. The guidelines of NFPA Standard No. 14 were followed in the design of standpipe systems.

The standpipes are supplied from four independent lead-ins on the underground main loop. The standpipes are cross-connected between the east-wing and the west-wing of the vitrification building providing valve stations for the automatic sprinkler systems.

AUTOMATIC WET-PIPE SPRINKLER SYSTEM

Automatic wet-pipe sprinklers are provided in accordance with NFPA Standard No. 13 except where equivalencies, exemptions, or other DOE approved supporting documentation exists to protect the area and equipment.

Specific areas provided with wet pipe sprinkler systems are identified in the Fire Control Preplans.

AUTOMATIC DRY-PIPE SPRINKLER SYSTEM

Automatic dry-pipe sprinklers are provided in accordance with NFPA Standard No. 13 except where equivalencies, exemptions, or other DOE approved supporting documentation exists to protect the area and equipment.

Specific areas provided with dry pipe sprinkler systems are identified in the Fire Control Preplans.

PILOT OPERATED DELUGE SYSTEM

These systems are designed and installed in accordance with NFPA Standard No. 13 and No. 15 except where equivalencies, exemptions, or other DOE approved supporting documentation exists.

Specific areas protected with deluge sprinkler systems are identified in the Fire Control Preplans.

WATER SPRAY SYSTEM

Water spray systems are designed and installed in accordance with NFPA Standard No. 15, except where equivalencies or exemptions exist. System operation is manually controlled. Manual operation is by push button that activates a timed solenoid operated control valve.

Specific areas protected with water spray systems are identified in the Fire Control Preplans.

HALOGENATED GAS SUPPRESSION SYSTEM

Halogenated gas suppression systems are of the total flooding type. Halon™ 1301 systems are designed and installed in accordance with NFPA Standard No. 12A except where equivalencies, exemptions, or other DOE approved supporting documentation exists.

For occupied areas (where personnel are normally present), the system is activated either by a single loop system of ionization detectors or manually by a Halon™ release switch. Actuation of the detection circuit causes a time delay before discharge of the Halon™ gas. The time delay is based on the time required for the safe egress of the occupants from the fire area. For unoccupied areas (where personnel are not normally present), the system is activated either automatically by a cross-zoned system of ionization and photo-electric detectors or manually by a Halon™ release switch. Actuation of this detector circuit causes a time delay before discharge of the Halon™ gas. The control panel provides power for the detection and actuation of the system; local, visual, and audible alarms; and system shutdown HVAC dampers. Each system includes a primary set of Halon™ storage containers and 100% capacity reserve set. Fire dampers and/or isolation dampers are installed on supply and exhaust air ducts to seal off the space during a fire.

Specific areas protected with Halon™ suppression systems are identified on the Fire Control Preplans.

FIRE EXTINGUISHERS

Extinguishers are mounted in readily accessible locations generally in main travel routes and in the vicinity of doors and stairwells. The number and type of extinguishers are in accordance with NFPA Standard No. 10.

Carbon dioxide extinguishers are provided for the Shielded Canister Transporter (SCT).

SCT ON-BOARD FIRE SUPPRESSION SYSTEM

An on-board Fire Suppression System is installed in the SCT engine enclosures. The system is designed to suppress Class B fires within an enclosed volume. The suppressing fluid is water-based and has film forming chemicals. The high pressure piston accumulators (nitrogen is the propellant) and special nozzles break the water into very small drops forming a cold water fog which cools down the temperature very rapidly and forces the air out as the water expands into steam reducing the oxygen concentration.

5.4.10.8 Fire Detection/Alarm System

The fire detection/alarm system will detect the operation of any signal initiating device, such as flow switch, pressure switch, manual pull stations, or any detector and send a signal to the fire alarm control panel. The signal is sent to SRSOC and then communicated to the DWPF central control room. The local fire alarm control panels are provided with secondary (standby) battery power.

The fire detectors furnished are either ionization, thermal (spot), thermistor (line), photoelectric, or a combination type, depending on the expected environment and combustibles in the room being served. Detectors are installed per NFPA Standard No. 72 requirements except where equivalencies, exemptions, or other DOE approved supporting documentation exists.

5.4.10.9 Fire Hazards Evaluation

Exposure to fire that threatens personnel and property can be minimized when the heat and smoke from a fire are confined to the area of origin of the fire.

The degree of fire resistance of a barrier is based on its intended purpose and the expected severity to which it is exposed. When the purpose of the barrier is to limit the fire size in locations without automatic fire protection systems, the barrier must withstand the maximum expected fire in the fire area until consumption of combustibles is complete.

The rating of a fire barrier or severity to which it is exposed is related to the intensity of a fire. For room conditions, a post-flashover fire can be considered to be fully developed. For large open volumes, as in the case for most DWPF areas, a fully developed fire can occur in a localized area without flashover to the entire volume. It is the fully developed fire condition that creates the most severe conditions for a fire barrier. In developing fires, the rate at which a fire will develop is dependent on the time the flame can spread from its ignition source to involve an increasingly large area of combustible materials. For most combustibles at the DWPF (with the

exception of flammable liquids), the growth or pre-flashover stage of a fire is where the average temperature is low and the fire is localized in the vicinity of its origin. For a fully developed or post-flashover fire, all the combustibles in the compartment are involved and flames fill the entire volume.

5.4.10.10 Fire Hazards Analysis

Manual 2Q (Ref. 25) provides a detailed method for preparing the Fire Hazard Analysis. Table 5.4-1 lists FHAs for various buildings / facilities at the DWPF. The facility fire protection group reviews and responds to the recommendations made in the FHAs.

5.4.10.11 Inspection and Testing Requirements

All fire protection systems (excluding supplemental systems) are designed, installed, and acceptance tested in accordance with NFPA Standards except where equivalencies, exemptions, or other DOE approved supporting documentation exists.

The operational integrity of the fire protection system (excluding supplemental systems) is ensured by the following:

- Installation of the fire protection system according to NFPA Standards except where equivalencies, exemptions, or other DOE approved supporting documentation exists.
- Inspection of the installed fire protection system in accordance with design specifications, vendor procedures, and NFPA Standards except where equivalencies, exemptions, or other DOE approved supporting documentation exists.
- Testing of the installed fire protection system in accordance with NFPA Standards except where equivalencies, exemptions, or other DOE approved supporting documentation exists.
- The sitewide standards for testing and maintenance of the fire protection equipment are covered in Manual 2Q, Fire Protection Program Manual (Ref. 25).

The fire protection system includes design features to facilitate inspection and testing of the fire protection system.

The operational integrity of the fire protection system will continue to be assured through the implementation of detailed procedures for periodic inspection and testing. These procedures are based on the guidance given in applicable NFPA standards.

5.4.10.12 Deleted

5.4.11 MAINTENANCE

Three distinct maintenance modes are available to meet the maintenance needs of the vitrification facility. The specific methods applied depend on the radiation and contamination

levels of the equipment involved. The RC staff participates in the selection of the maintenance mode to be applied. The modes are as follows:

- **Remote Maintenance:** Remote maintenance is used to service and repair equipment that, because of high radiation and contamination levels, cannot be directly contacted by personnel. The equipment must be serviced using special systems and tools that allow personnel to remain shielded from the radiation fields while repairing or servicing the equipment. Remote maintenance techniques are used in the process and mechanical cells, the mercury purification and sampling cells, the glass waste storage vaults, the remote equipment decontamination cell, and any other area where high radiation levels or contamination are encountered.
- **Standard Maintenance:** Routine maintenance is the application of standard industrial techniques for equipment service and repair when there are no special requirements due to the presence of radiation or radioactive contamination.
- **Contact Maintenance:** Contact maintenance is service and repair of equipment which is directly contacted by personnel and where radiological protection is required to perform the activity. This activity is typically performed in the RRW, CMA, and CDMC.

Preventive maintenance requirements were factored into the design and specification of components and equipment through detailed reviews. Preventive maintenance requirements for equipment located in nonradioactive or low level radioactive process areas, where contact maintenance is usually performed, are specified by the Design Authority. In the case of remote equipment, whose location is normally in high level radioactive process areas, preventive maintenance requirements were minimized by specifying special design requirements.

Facility design requirements for maintenance of process and service equipment within DWPF were reviewed to ensure that maintenance personnel could safely and effectively perform their assigned duties. Design considerations included equipment decontamination facilities, remote equipment repair and test facilities, equipment access, overhead monorail and crane systems, ease of replacing or removing equipment through process areas to maintenance areas, use of a freight elevator, lighting systems, viewing systems, and electromechanical manipulators. Contaminated equipment can be transported into the Vitrification Building as necessary.

Maintenance supports waste vitrification activities while maintaining occupational exposures as low as reasonably achievable. Equipment and system designs are reviewed for radiation hazards associated with removal and replacement or in-place maintenance and includes:

- Features are included in the site design that facilitate maintenance, while confining radioactive contamination.
- The exterior of contaminated equipment is decontaminated with steam, nitric acid solution, CO_2 pellets, and/or detergents.
- Stainless steel lining is installed in cells and other areas, such as the crane maintenance area, which are expected to require frequent decontamination.
- Shielding is used to reduce radiation exposure of maintenance personnel.

- Equipment installed in the process and mechanical cells is remotely accessible by a crane, hoist, and/or manipulator. The lifting and handling equipment design includes retrieval provisions to return a disabled unit to a shielded repair location.
- Building layout and material transport routes are arranged to minimize transit times and minimize passing through areas of higher radiation exposure to reach areas of lower exposure.
- Viewing and lighting systems are provided to expedite maintenance activities, as well as routine operations.

5.4.12 GLASS FRIT FEED AND STORAGE

5.4.12.1 Function

The glass frit facilities receive, store, and prepare glass frit and glass frit slurry for use in glass making and canister decontamination.

5.4.12.2 Components

Major components of the glass frit facilities include the following:

- Frit tote bins
- Frit tote bin inverter
- Dust collector
- Screw conveyor
- Bucket elevator
- Frit weigh bin
- Frit slurry makeup tank
- Decon frit slurry feed tank
- Process frit slurry feed tank
- Agitators
- Transfer pumps
- Air spargers

Components of the glass frit facilities are located in Building 422-S and in the radiological area of Building 221-S.

A dust collector (with blower) collects dust from conveyers, the bucket elevator, the frit weigh bin, and other minor system components and discharges it to a drum.

The frit slurry is pumped to the process frit slurry feed tank in Building 221-S. Decon frit is added (dry) to process water at the Decon Frit Tank.

Decon frit slurry is fed to the canister decon operation, and process frit slurry is fed to the slurry mix evaporator.

5.4.13 COLD CHEMICAL SYSTEMS

5.4.13.1 DWPF Cold Chemical System (excluding 512-S)

FUNCTION

The cold chemical system provides the necessary chemicals for process requirements, decontamination, and neutralization operations.

COMPONENTS

Bulk liquid chemicals and dry chemicals are received and stored in designated locations throughout the facility. After preparation, the cold chemicals are transferred to feed tanks in radiological areas on the first and third levels and on the mezzanine of the Vitrification Building and to the Chemical and Industrial Waste Treatment Facility. Spills, overflows, and drains in the Vitrification Building are collected in separate floor drain, acid drain, and organic acid drain catch tanks located on the tunnel level. Nonradioactive solutions from the floor drain and organic acid drain catch tanks are discharged to the chemical and industrial waste treatment system. Radioactive solutions are discharged to the recycle collection tank or the decon waste treatment tank. Spills, overflows, and drains in Building 422-S outside facilities are collected in diked areas that drain to either the caustic, nitric acid, or organic acid sumps. Catalyst solutions drain to a catalyst sump that discharges back to the catalyst tanks.

The following are major components of the cold chemical system:

Cold Chemical Storage and Makeup

- 50% nitric acid portable storage tank
- Nitric acid decon makeup tank
- Sodium nitrite makeup tank
- Caustic storage tank
- Oxalic acid makeup tank
- Decon solution makeup tank
- Formic acid dilution tank
- Dilute formic acid feed tank
- Catalyst makeup tank
- Potassium nitrate makeup tank
- Boric acid makeup tank
- Formic Acid storage tank No. 1 and No. 2
- 21,000 gal tank not designated (previously HAN Storage Tank)

Cold Chemical Feeds

- 90% formic acid feed tank
- Nitric acid dilution tank
- Caustic feed tank
- Off-gas chemical feed tank
- Flush water feed tank
- Sodium nitrite feed tank
- Nitric acid feed tank
- Catalyst feed tank
- Additive mix/feed tank
- 600 gal tank not designated (previously HAN Feed Tank)
- Oxalic acid decon feed tank
- Nitric acid decon feed tank

Cold Chemical Waste Collection

- Acid drain catch tank
- Organic acid drain catch tank
- Floor drain catch tank and spare tank
- Nitric acid sump pump
- Catalyst sump pump
- Organic acid sump pump
- Caustic sump pump

Cold Chemical Ventilation

- Cold feed vent system
- Acid vent system
- Organic acid vent system

Equipment is provided in systems to agitate, sample, transfer, heat, and cool solutions as required.

A portable tank supplies bulk concentrated nitric acid. A container lift truck is used to transport the portable tank.

5.4.13.2 512-S Cold Chemical System

FUNCTION

512-S Cold Chemical Feed System can provide MST to the LWPT, oxalic acid to the Filter Cleaning System, and NaOH to both systems. When MST is utilized, it is typically added to the Salt Solution before it is pumped to the LWPT but the ability to add MST to the LWPT in 512-S is retained as an off-normal evolution.

COMPONENTS

The 512-S Cold Chemical Feed System is composed of the MST (added through a funnel), the Caustic Feed System (NAK), and the Oxalic Acid System (OSK).

The 512-S Cold Chemical Feed System, located North of the 512-S Building, provides a centralized location for the delivery, storage, and supply of cold feed chemicals to 512-S. The chemicals are vendor supplied by truck and transferred into storage located in the Cold Chemical Storage Area (512-7S).

Each of the Cold Feed Chemical Systems is composed of various types of pumps, storage tanks/containers, and filters. The three categories of pumps used in the Cold Chemical Feed System are unloading pumps, feed pumps and metering pumps. The Caustic Feed System and Oxalic Acid System each have an unloading pump and a feed pump. The unloading pumps are used for the transfer of the specific chemical from the supply truck to its storage tank. The feed pumps are used for the distribution of the chemicals throughout 512-S. The Caustic Feed System uses metering pumps to control the volume of NaOH provided to users where volumes and concentrations are important to the process. Filters are used in the Caustic Feed System and Oxalic Acid System to remove suspended particles from solution in order to protect the crossflow filter from plugging.

The Cold Chemical Feed System is located on a concrete diked area, covered with a roof. Various components of each system (tank, pump, filter, pipes…) are heat-traced and insulated to provide freeze protection for outdoor services.

The Cold Chemical Feed system provides:

- MST (15 wt. % nominal) to the LWPT
- Caustic (50 wt. % nominal) to LWHT, LWPT, Back Pulse Tank, and Surge Tank
- Dilute caustic to LWHT, LWPT, Back Pulse Tank, and Surge Tank
- Oxalic acid (0.6 M nominal) for crossflow filter and secondary filter cleaning
- Water to the LWHT, LWPT, Back Pulse Tank, and Surge Tank.

5.4.13.3 Cold Chemical System Considerations

Additional design features for the cold chemical system include the following:

- Tanks have spill dikes that provide containment for the contents of the largest tank within the diked area as well as segregation of incompatible liquids.
- With the exception of the off-gas chemical feed tank, tanks have high level alarms and interlocks to prevent overfilling.
- Concentrated formic acid tanks are nitrogen blanketed if in use. Non-formic acid tanks are air-purged.
- The Organic Acid Drain Catch Tank in the Vitrification Building is vented to the cold feed vent system.
- The chemical supply lines into the canyon have seal pots, or air purges, to prevent radioactive material from backing up into the lines.
- Tanks overflow into either diked areas with sump pumps or to the acid, floor, or organic acid drain catch tanks.
- Formic acid storage tanks include flame arrestors and relief valves.

5.4.14 NITROGEN SYSTEMS

5.4.14.1 422-S Nitrogen Supply System

Nitrogen gas systems supply users for purging, blanketing, pressurizing, measuring, sampling, and analyzing. The system includes the following major components:

- One liquid nitrogen storage tank
- Ambient vaporizers
- Distribution piping with pressure regulators, pressure relief valves, and shut-off valves
- Instrumentation and controls

Under normal conditions, the liquid nitrogen storage tank supplies liquid nitrogen to one of the ambient vaporizers. The vaporizer converts the liquid nitrogen to nitrogen gas. Nitrogen gas may also be supplied from a vendor supplied tank truck and vaporizer at a connection in the nitrogen distribution piping. The nitrogen is delivered via the distribution piping to the following users:

- Low Point Pump Pit Primary Purge System
- CPC Primary Purge System
- Formic Acid Storage and Feed Tanks
- Shielded viewing windows

- Cold Chemical and Drain Collection samplers
- Plug Welder ram and Canister Trolley (nitrogen gas cylinder backup is located in the Vitrification Building)
- Organic Lab Hoods and Analytical Cells

The storage tank and vaporizers are located outdoors near the Cold Feed Storage Area (422-S). Outside overhead piping delivers gaseous nitrogen to the Pump Pit. Piping within the Cold Feed Storage Area (422-S), the Service Building (210-S), and the Vitrification Building (221-S) delivers gaseous nitrogen to other users.

The design of the nitrogen systems includes the following:

- Liquid nitrogen system piping connections are designed for nitrogen service per Compressed Gas Association (CGA) Standards. This prevents hazards that could arise from the inadvertent connection of other gases.
- The 422-S nitrogen system requires no electrical power to operate.

5.4.14.2 <u>512-S Nitrogen Supply System</u>

The 512-S Nitrogen Supply System receives and stores liquid nitrogen, converts the liquid nitrogen to a gas and then distributes the gaseous nitrogen throughout the 512-S at various pressures and flow rates. The primary uses of the Nitrogen System are flammability control (hydrogen), backpulsing, instrumentation, and valve operator motive force.

The Nitrogen System has a bulk storage/supply. Liquid nitrogen is delivered to the site by truck and stored in the nitrogen storage tanks. Liquid nitrogen from the bulk nitrogen storage tank(s) are supplied to the nitrogen system vaporizers, which convert the liquid nitrogen to gaseous nitrogen. The gaseous nitrogen is then distributed to the 512-S loads.

The 512-S Nitrogen System includes the following major components:

- Nitrogen Storage Tank(s)
- Nitrogen Vaporizer(s)
- Distribution piping with pressure regulators, pressure relief valves, and isolation valves
- Instrumentation, controls and alarms

The 512-S Nitrogen System distributes 150 psig (nominal) nitrogen to the following loads:

- LWPT Purge
- LWHT Purge
- Backpulse Tank Pressure
- Surge Tank Purge

- LWPT Tank Bubblers and Gages
- LWHT Bubblers
- Transfer Jet Gang Valves
- Nitrogen System 150 psig Pneumatic Valves

The 512-S Nitrogen System distributes 80 psig (nominal) nitrogen to the following loads:

- Caustic valve actuators
- PPV isolation valve actuators
- Domestic water valve actuators
- Backpulse valve actuators
- Wash water valve actuators
- Deionized water valve actuators
- Nitrogen system 80 psig pneumatic valves
- Domestic water valve actuators
- Backpulse valve actuators

5.4.14.3 CPC Safety Grade Nitrogen Purge System

The 221-S nitrogen gas system supplies the CPC purge system users with nitrogen for purging and blanketing. The system includes the following major components:

- Six safety grade liquid nitrogen storage tanks
- Two ambient vaporizers
- Distribution piping with pressure regulators, pressure relief valves, and shut-off valves
- Instrumentation

Under safety grade purging conditions, the safety grade liquid nitrogen storage tanks supply liquid nitrogen to the CPC ambient vaporizers. The vaporizer converts the liquid nitrogen to nitrogen gas. Nitrogen gas may also be supplied from a vendor supplied tank truck and vaporizer at a connection in the nitrogen distribution piping. The gaseous nitrogen is delivered via the distribution piping to selected CPC and SPC process vessels.

The storage tanks and vaporizers are outside of Building 221-S.

The design of the nitrogen systems includes the following:

- Liquid nitrogen system piping connections are designed for nitrogen service per Compressed Gas Association (CGA) Standards. This prevents hazards that could arise from the inadvertent connection of other gases.

- The nitrogen systems require no electrical power to operate.

5.4.14.4 Deleted

5.4.14.5 LPPP Safety Grade Purge System

The LPPP Safety Grade Purge System supplies the LPPP following a loss of the Primary Purge System (See Section 5.3.2.8). The Safety Grade Purge System includes the following major components:

- One safety grade liquid nitrogen storage tank
- Ambient vaporizer
- Distribution piping with pressure regulators, pressure relief valves, and shut-off valves
- Instrumentation
- Chemical feed lines to which nitrogen bottles can be connected

Under safety grade purging conditions, the safety grade liquid nitrogen storage tank supplies liquid nitrogen to the ambient vaporizer. The vaporizer converts the liquid nitrogen to gaseous nitrogen. Nitrogen gas may also be supplied from a vendor supplied tank truck and vaporizer at a connection in the nitrogen distribution piping. The gaseous nitrogen is delivered via the distribution piping to the LPPP Safety Grade Purge System. The storage tank, vaporizer, and cylinders are outside of the LPPP.

The design of the nitrogen systems includes the following:

- All liquid nitrogen system piping connections are designed for nitrogen service per Compressed Gas Association (CGA) Standards. This prevents hazards that could arise from the inadvertent connection of other gases.
- The nitrogen systems require no electrical power to operate.

5.4.15 DECONTAMINATED EQUIPMENT AND WASTE STAGING (DEWS)

Decontaminated equipment and glass-contaminated equipment is stored in an outside location. The decontaminated equipment from DWPF may be stored in engineered containers (SeaLand or equivalent). Up to five containers of decontaminated or glass-contaminated equipment can be stored, no more than two of these five containers can be double-height containers. The equipment stored in these containers may consist of transfer pumps, jumpers, and other miscellaneous equipment and may contain only residual amounts of radioactive material (Ref. 46). Additionally, up to two containers (SeaLand or equivalent) may be used for the storage of drums (nominally 55-gallon) containing glass-contaminated equipment (Ref. 57). Alternate storage containers may be used provided they do not exceed the total storage volume assumed.

Staged waste is also stored in an outside location. The staged waste may be stored in approved containers (e.g., B-25, B-12, SeaLand or equivalent, etc.) and may contain transuranic or low-level waste. For the staged waste, the structural integrity of these staged waste containers is

maintained per the Waste Certification Plan (Ref. 62). There is no limit to the number of waste containers staged in an outside location.

5.5 RADIATION SAFETY AND SHIELDING DESIGN

NOTE: The DWPF was originally designed for processing both sludge from Extended Sludge Processing (ESP) and supernate/precipitate from the In-Tank Precipitation (ITP) process. The precipitate stream from ITP has been removed from the DWPF flowsheet and a new Actinide Removal Process (ARP) stream has been added. Even though the supernate/precipitate stream is no longer a part of the DWPF process, some of the DWPF shielding design (e.g., Vitrification Building cells, sand filter, etc.) is based on this stream and therefore is discussed in the following sections. Additionally, a comparison of the ARP generated stream radioactive nuclide concentrations to the concentrations in the SRAT concluded that, replacing DWPF sludge in the SRAT with ARP generated MST/Sludge Solids on a gallon for gallon basis, will not impact the radiation shielding requirements in the Vitrification Building or in downstream facilities (e.g., GWSB #1) (Ref. 43). Radiation shielding design for GWSB #2 was evaluated (Ref. 52), subsequent to the above process, using a modified glass stream (Ref. 51). The addition of large amounts of sludge to the Recycle and DWTT Streams increased the source terms located in the RCT, RPT, DWTT, and recycle transfer lines, but did not impact the radiation shielding requirements (Ref. 58).

5.5.1 RADIATION SOURCES

High level radioactive liquid wastes that have been generated on the Savannah River Site as a result of weapons production operations are vitrified in the DWPF. Because these wastes are highly radioactive, personnel in the DWPF must be protected from exposures to ionizing radiation and radioactive materials.

This subsection identifies and describes the sources of radiation within the DWPF facilities. These sources of radiation are the basis for the shielding and radiation safety design of the plant.

5.5.1.1 Contained Sources

Radioactive liquid waste was planned to be received in the DWPF in two forms: as an insoluble sludge and a precipitate slurry. The sludge contains the majority of the radioactivity in the waste. For shielding calculations, the design basis sludge was assumed to be five years out of reactor material. The precipitate is produced from the supernatant liquid that was separated from the sludge. For shielding calculations, the design basis precipitate was assumed to be fifteen years out of reactor material.

The basis for the DWPF shielding source terms is the Curie Balance that is produced from the DWPF Material Balance. The Curie Balance is discussed in Reference 1 and identifies the radioisotopes and gamma photon energy emission rates for each major process stream in the facility. The Curie Balance tables are based on previous SRS operation production forecasts

and represent a projected maximum value for the overall curie content that was used as the basis for the shielding design in DWPF.

The Curie Balance included data for two processing schemes: one for processing sludge only in the DWPF; the other for processing both sludge and supernate. Shielding analyses were generally performed for both processing schemes, and the shielding requirements are based on the more conservative of the two.

Radionuclide concentrations for the major process streams are given in the following tables: Table 5.5-1 (sludge slurry stream), Table 5.5-2 (supernate/precipitate slurry stream), Table 5.5-3 (glass stream - sludge), and Table 5.5-3a (glass stream - sludge plus supernate/precipitate), Table 5.5-3b (glass stream, maximum projected for GWSB #2 - sludge plus supernate/precipitate), Table 5.5-4, (512-S - ARP streams), and Table 5.5-4a (MCU-SE Stream). The design bases values included in these tables are based on data and process summary diagrams from the April 1983 Curie Balance (Ref. 31). This is conservative with respect to the curie balance used for the calculation of consequences discussed in Chapter 9 and is protected by the TSRs. The ARP values included in these streams are based on the Curie Balance (Ref. 44) provided to support ARP which is also protected by the WAC (discussed in Chapter 11, Section 11.5.11.2.11). The SE values included in these streams are based on the Curie Balance (Refs. 55, 59) provided to support the safety analysis for DWPF which is also protected by the WAC (discussed in Chapter 11, Section 11.5.11.2.11).

The shielding design of GWSB #2 vault (Ref. 52) used a higher source stream (Ref. 51) than used for the GWSB #1 vault. However, the consequences for accidents involving the GWSB #2 used the current source stream currently authorized for GWSB #1 (Refs. 53, 64).

The addition of large amounts of sludge to the Recycle and DWTT Streams increased the source terms located in the RCT, RPT, DWTT, and recycle transfer lines, but did not impact the radiation shielding requirements (Ref. 58).

5.5.1.2 Airborne Radioactivity Sources

Under normal conditions, airborne radioactivity within the Vitrification Building process cells, the LPPP tank cells, and the 512-S cells is confined by the structures and the applicable HVAC systems. Airborne radioactivity is filtered prior to release.

Table 5.5-15 shows the expected concentrations of radioactivity in the Vitrification Building Zone 1 HVAC exhaust. These concentrations can be taken to be representative of airborne concentrations in both the Vitrification Building process cells, the LPPP tank cells, and the 512-S cells. The airborne radioactivity concentrations in any of the Glass Waste Storage Building vaults is expected to be negligible since the emplacement of canisters with significant external contamination levels is not allowed.

Airborne radioactivity can impact radiation shielding and can be a source of radiation exposure to operating personnel. At the DWPF, the areas containing significant airborne radioactivity are all heavily shielded due to the contained radiation sources (see

Subsection 5.5.1.1). Therefore, this shielding will be unaffected by the airborne radioactivity present.

Processes and activities at DWPF with the potential for producing airborne radioactivity include engineering controls to limit releases and worker exposures. The Contact Decontamination Maintenance Cell (CDMC) and the Crane Maintenance Area (CMA) are the two primary areas accessible to DWPF workers for maintenance that could have high airborne radioactivity levels. It is estimated that the contamination level of equipment in the CDMC and CMA will not exceed a level of 1E+07 dpm/100 cm^2 after decontamination. Airborne activities in jobs involving simple material movement in the CDMC and CMA typically should not exceed 50 Derived Air Concentrations (DACs). In contrast, jobs in the CDMC and CMA involving vigorous material movement or the use of power tools to cut, shape or abrade material could result in airborne radioactivity concentrations as high as 10,000 DAC.

With regard to personnel exposure in these areas, and other areas where the potential for producing airborne radioactivity exists, personnel access is not allowed except in controlled situations such as for maintenance. Activities would be carried out under the guidance of Radiological Control personnel and would utilize radiation monitoring and respiratory protection equipment as necessary. The overall impact of airborne radioactivity sources on DWPF personnel will be minimal.

5.5.2 RADIATION PROTECTION DESIGN FEATURES

This subsection describes the considerations applied to the design of the DWPF for the purpose of protecting facility personnel from exposure to radiation.

5.5.2.1 Design Considerations

The radiation protection design of the DWPF has two goals: to limit the total annual exposure to less than 1 rem per person and to keep individual and collective exposures As Low As Reasonable Achievable (ALARA). The DWPF design achieves the radiation protection design goals by addressing the following two objectives:

- Minimize the need for, and duration of, personnel access into high radiation areas
- Establish radiation levels as low as practicable in routinely occupied areas

These objectives are met by applying the following facility and equipment design considerations.

FACILITY DESIGN CONSIDERATIONS

The DWPF design includes the following facility design considerations related to radiation protection:

- Access control provisions in the DWPF prevent unnecessary or inadvertent exposure to radiation.

- The radiation shielding design of the DWPF limits dose rates in areas that may be occupied by personnel to levels that assure that the exposure objectives for the facility can be met. The shielding design limits the maximum dose rate in areas routinely occupied by personnel to a maximum of 0.5 mrem/hr for existing facilities and new facilities. It also limits the dose rates in intermittently occupied areas (areas occupied by personnel for less than 10% of the normal work year) to a maximum of 5.0 mrem/hr.
- Dose rates outside of radiation shields can vary considerably depending on the position of the detector point with respect to the radiation sources. Therefore, the average dose rates in both routinely and intermittently occupied controlled areas will be significantly lower than the corresponding design limits. Also, dose rates outside controlled areas will be much lower than 0.5 mrem/hr because of distance effects.
- The radiation shielding design of the DWPF accounts for streaming along discontinuities introduced by entry ways, penetrations, embedments, expansion joints, and the like. The shielding design also considers contributions from scattered radiation. The shielding design limits these effects to meet the design criteria for continuously occupied and intermittently occupied areas described above. Due to much lower neutron activity concentrations (particles per sec) when compared to photon activity concentrations, in most cases the shielding required for the photon component of the waste drives the required shield thickness.
- The designs of the ventilation systems for the DWPF confine airborne radioactive material to areas not routinely occupied by personnel. The ventilation system is designed such that air is drawn from the RPC plenum and exhausts through the process cells below when the ventilation covers are installed.
- Fixed area radiation monitors and airborne radioactivity monitors located throughout the controlled portions of the DWPF provide facility personnel with information on the radiological conditions in the plant. The alarm setpoints of these monitors alert personnel of airborne radioactivity and elevated dose rates.
- Decontaminable surfaces are provided in areas that can be accessed by personnel and have a high potential for surface contamination.
- The Vitrification Building includes two decontamination areas within the remote process cell: the Remote Equipment Decontamination Cell (REDC) and the Contact Decontamination and Maintenance Cell (CDMC). In the REDC, equipment exhibiting high radiation levels can be decontaminated remotely. Once equipment dose rates have been sufficiently reduced in the REDC, the item can be moved into the CDMC for hands-on maintenance. The CDMC walls and removable cell covers provide sufficient shielding to allow personnel access to the CDMC during normal DWPF operation, except when large sources of radiation (e.g., melter, tanks, tank coils, melter off-gas HEPA filters, PVV filter, FAVC, and HEME) are above the cell covers.

- The DWPF recycles all radioactive process wastes. Therefore, there are no personnel exposures associated with the management of these wastes.
- The DWPF provides for onsite storage of solid wastes such as failed equipment. These wastes are stored in shielded concrete vaults for eventual disposition.

EQUIPMENT DESIGN CONSIDERATIONS

The DWPF is designed to be a remotely operated and, for the most part, remotely maintained facility. As a consequence, fewer explicit radiation protection design features are required for the equipment (as opposed to the facility). Nevertheless, the DWPF design does include the following equipment design considerations related to radiation protection:

- The design of in-cell DWPF equipment provides for remote maintenance, removal, and replacement.
- The design of the DWPF provides the capability to remotely decontaminate radioactive equipment.
- All radioactive equipment in the DWPF process cell is remotely operated from low radiation areas to reduce personnel exposure.
- Equipment has been selected to be compatible with its service environment to reduce maintenance requirements.
- Remote viewing devices are employed in the design including CCTVs and shielded viewing windows.
- The main process cell crane in the Vitrification Building has several radiation reduction features inherent in its design. These include:
    - The crane is remotely operated.
    - The crane is equipped with an electrical equipment compartment that travels in a separate runway located in a shielded bus bar corridor.
    - The crane is designed to be decontaminated for maintenance.
    - If mechanical failure prevents load release, the crane has hoist cable cutters that can be operated remotely from the shielded bus bar corridor. Similarly, the bridge is equipped with jack-down wheels as emergency backup in case of wheel failure. The jack-down wheels are also operable from the shielded bus bar corridor.
- Fume hoods and glove boxes in the Vitrification Building are provided for the handling of radioactive process fluid samples outside of the shielded process cells. All hoods and gloveboxes are exhausted through HEPA filters to the Zone 2 exhaust system. The following is included:
    - Analysis of liquid process samples is performed in fume hoods and gloveboxes in the Analytical Laboratory area on the Mezzanine Level of the Vitrification Building. Highly radioactive liquid samples are diluted in the analytical cells.

Diluted samples are then transported via a glovebox to fume hoods and radiobenches, where various analyses are performed.

- Gas sampling fume hoods are provided for receipt and analysis of process gas samples.
- Final mercury purification equipment is provided in a fume hood.
- A radiobench hood is provided at the CDC smear test station for retrieval of smear test samples from the CDC and WTC.

- The Shielded Canister Transporter (SCT) is designed to minimize operator exposures. The operator's cab is designed for intermittent occupancy. Protection is also provided to limit exposures to adjacent personnel from radiation streaming when loading or unloading canisters.

DESIGN ORGANIZATION

The nuclear project group within Bechtel National, Inc. (BNI) had primary responsibility for developing the radiation protection design for the DWPF. The nuclear group supervisors and discipline engineers had substantial experience in radiation protection and radiological engineering. The radiation protection requirements were documented in Shielding and Radiation Zoning Drawings. The information on these drawings was incorporated into construction documents by the structural and instrumentation groups on the project. The DuPont Engineering Department - Wilmington was the design oversight organization during the development of the DWPF radiation protection design. The DWPF Engineering Department has primary radiation protection responsibilities for current and future design activities. The Shielding and Radiation Zoning Drawings are given in SDD SU-26 (Ref. 39). The DWPF Engineering Department has primary radiation protection responsibilities for current and future design activities.

The BNI nuclear project group was responsible for reviewing design documents prepared by other disciplines to assure incorporation of appropriate radiation protection features. The nuclear group reviews included the following documents:

- Concrete outline drawings to assure that minimum bulk shielding requirements were being met.
- Equipment location drawings to assure that the geometries used in the shielding design conservatively reflected actual arrangements.
- Penetration details to assure that adequate supplemental shielding was provided to compensate for voids.
- Shielded viewing window details to assure consistency with bulk shielding requirements and to assure that there would be no streaming around the shielded viewing windows.
- Drawings for the shielded canister transporter to assure consistency of the design of this equipment with the bulk shielding requirements.

- Specifications for mechanical, electrical, and instrumentation equipment to assure compatibility with the radiation service environment.

ALARA PROGRAM

ALARA at the DWPF is assured by implementation of the design considerations and design reviews described above. In addition, site personnel intimately familiar with the operation of similar facilities at SRS worked closely with project personnel, performing informal reviews of in-process drawings and designs. This ensured that the successful operating experience at SRS was factored into the DWPF and provided further assurance that the DWPF design is ALARA.

DOE Order 5480.11 and DOE/EV/1830-T5 were not design criteria for the DWPF. However, the radiation protection design goals and design considerations described above are consistent with the requirements of DOE Order 5480.11 and DOE/EV/1830-T5.

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62. Waste Certification Plan for Liquid Waste Facilities. Q-ESR-G-00055.

63. Savannah River Remediation Fire Protection Program Plan. F-PRP-G-00001, Rev. 1.

64. McAllister, J.E. Evaluation of Consequences for DWPF Design Basis Accidents with Revised Control Strategy for PISA Resolution, S-CLC-S-00153, Rev. 1.

Table 5.4-1
DWPF Fire Hazard Analyses

BUILDING/ FACILITY NUMBER	BUILDING/ FACILITY	FIRE HAZARD ANALYSIS DOCUMENT NUMBER	CONSTRUCTION CLASSIFICATION
210-S	Service Building	F-FHA-S-00008	Type II-N, Group B, Div. 4
221-S	Vitrification Building	F-FHA-S-00008	Type I FR, Group B, Div. 4
250-S	Glass Waste Storage Building #1	M-FHA-S-00004	Type II-N, Group B, Div. 4
251-S	Glass Waste Storage Building #2	M-FHA-S-00014	Type II-N, Group B, Div. 4
260-S	Failed Equipment Storage Vault	M-FHA-S-00012	Equivalent Type I, Group B, Div. 4
292-S	Fan House	F-FHA-S-00008	Type I FR, Group B, Div. 4
422-S	Bulk Frit and Cold Feed Storage	F-FHA-S-00008	Type II-N, Group H, Div. 3
511-S	Low Point Pump Pit	F-FHA-S-00010	Type II-N, Group B, Div. 4 Occupancy
512-S	512-S	F-FHA-S-00012	Type II-N, Group B, Div. 4 Occupancy
951-S	Primary Substation	M-FHA-S-00008	Type II-N, Group H, Div. 4
980-S	Water and Chemical Waste Treatment	M-FHA-S-00007	Type II-N, Group H, Div. 3 Occupancy
981-S	Cooling Tower	M-FHA-S-00005	Type II-N, Group B, Div. 4 Occupancy

Table 5.4-2
Applicable Fire Protection Codes and Standards

PROJECT	S-1780	S-4620 *
DOE Orders	5480.7 6430.1	5480.4 5480.7A 6430.1A
Other Mandatory Criteria	UL (1983) FM (1983) SBC (1979) UBC (1984)	UL FM SBC UBC DOE/EP-0108 DOE/EV-0043, 8-79 CFR 29, Parts 1910 & 1926
National Fire Codes	NFPA 10(1981) NFPA 11(1983) NFPA 12(1985) NFPA 12A(1980) NFPA 13(1983) NFPA 13A(1983) NFPA 14(1983) NFPA 15(1985) NFPA 20(1985) NFPA 22(1981) NFPA 24(1981) NFPA 30(1981) NFPA 37(1979) NFPA 70(1981) NFPA 72A(1983) NFPA 72D(1979) NFPA 72E(1982) NFPA 80(1983) NFPA 90A(1981) NFPA 101(1981) NFPA 214(1983)	NFPA

Table 5.4-2

Applicable Fire Protection Codes and Standards (Continued)

PROJECT	S-1780	S-4620 *
SRS Criteria	WSRC-RP-92-1186 (Basic Data Report) DPHR-38, Rev. 1 (Design Process Hazards Review) QA Planning Reports: - QAPR S-1780-210-M-001, Rev. 2 - QAPR S-1780-221-M-001, Rev. 3 - QAPR S-1780-221-M-002, Rev. 2 - QAPR S-1780-980-M-001, Rev. 2 - QAPR S-1780-422-M-001, Rev. 1 - QAPR S-1780-111-M-001, Rev. 0	2Q, Rev. 1
Seismic Criteria **	UBC (1984), seismic zone 2	Seismic Engineering Procedure SEP-26 (Seismic Criteria for Fire Protection System Components)

* The code of record for project 4620 is contained within the Functional Design Criteria. The Functional Performance Requirements also contains some criteria.

** Pipe hangers and supports for fire suppression systems and standpipe systems are designed and installed in accordance with applicable NFPA standards.

Note: A year listed in parentheses in the table indicates the edition year effective when the DWPF design commenced.

Table 5.5-1
Shielding Design Bases - Radionuclide Composition of Sludge Slurry

Isotope	Activity, Ci/gal	Isotope	Activity, Ci/gal	Isotope	Activity, Ci/gal
H-3	6.34E-05	Sb-124	1.23E-10	Eu-155	8.21E-01
C-14	1.32E-09	Sb-125	1.43E+00	Tb-160	1.93E-09
Cr-51	1.53E-19	Sb-126	3.64E-06	Tl-208	1.81E-06
Co-60	2.94E-01	Sb-126m	2.60E-04	U-232	1.46E-04
Ni-59	2.39E-03	Te-125m	3.42E-01	U-233	1.74E-08
Ni-63	2.97E-01	Te-127	1.49E-04	U-234	4.60E-04
Se-79	2.34E-04	Te-127m	1.53E-04	U-235	1.53E-06
Rb-87	1.56E-08	Te-129	3.80E-15	U-236	3.34E-05
Sr-89	9.09E-08	Te-129m	5.91E-15	U-238	8.53E-06
Sr-90	5.17E+01	I-129	1.24E-05	Np-236	3.00E-11
Y-90	5.32E+01	Cs-134	3.03E-01	Np-237	1.52E-05
Y-91	1.65E-06	Cs-135	5.28E-06	Pu-236	1.06E-04
Zr-93	1.94E-03	Cs-137	2.86E+00	Pu-237	7.77E-15
Zr-95	1.74E-05	Ba-137m	2.70E+00	Pu-238	1.29E+00
Nb-94	9.40E-07	Ce-141	6.18E-14	Pu-239	1.21E-02
Nb-95	3.67E-05	Ce-142	1.64E-08	Pu-240	7.70E-03
Nb-95m	2.15E-07	Ce-144	1.69E+01	Pu-241	1.45E+00
Tc-99	4.26E-03	Pr-144	1.69E+01	Pu-242	1.06E-05
Ru-103	2.02E-11	Pr-144m	2.04E-01	Am-241	1.86E-02
Ru-106	2.69E+00	Nd-144	8.28E-13	Am-242	2.45E-05
Rh-103m	1.96E-11	Pm-147	4.15E+01	Am-242m	2.47E-05
Rh-106	2.64E+00	Pm-148	1.19E-13	Am-243	9.89E-06
Pd-107	1.57E-05	Pm-148m	1.73E-12	Cm-242	6.03E-05
Ag-110m	2.25E-02	Sm-147	3.37E-09	Cm-243	9.53E-06
Cd-113	6.52E-17	Sm-148	9.77E-15	Cm-244	2.80E-04
Cd-115m	1.57E-12	Sm-149	3.00E-15	Cm-245	1.14E-08
Sn-121m	5.13E-05	Sm-151	4.19E-01	Cm-246	9.10E-10
Sn-123	4.55E-04	Eu-152	6.37E-03	Cm-247	1.12E-15
Sn-126	2.58E-04	Eu-154	1.07E+00	Cm-248	1.17E-15
Total activity		1.99E+02	Ci/gal		

Table 5.5-2
Shielding Design Bases - Radionuclide Composition of Supernate / Precipitate Slurry
(See Note in Section 5.5)

Isotope	Activity, Ci/gal
H-3	6.03E-05
Sr-89	8.24E-10
Sr-90	4.68E-01
Cs-134	2.45E+00
Cs-135	5.44E-04
Cs-137	2.37E+02
Ba-137m	2.24E+02
Pu-236	1.07E-06
Pu-237	7.96E-17
Pu-238	1.30E-02
Pu-239	1.23E-04
Pu-240	7.79E-05
Pu-241	1.47E-02
Pu-242	1.08E-07
Total Activity	4.64E+02 Ci/gal

Table 5.5-3
Shielding Design Bases - Radionuclide Composition of Glass from Sludge

Isotope	Activity, Ci/lb	Isotope	Activity, Ci/lb	Isotope	Activity, Ci/lb
Cr-51	3.34E-20	Sb-125	3.12E-01	Tb-160	4.21E-10
Co-60	6.42E-02	Sb-126	7.93E-07	Tl-208	3.95E-07
Ni-59	5.22E-04	Sb-126m	5.66E-05	U-232	3.19E-05
Ni-63	6.48E-02	Te-125m	7.27E-02	U-233	3.80E-09
Se-79	4.97E-05	Te-127	3.18E-05	U-234	1.00E-04
Rb-87	3.31E-09	Te-127m	3.24E-05	U-235	3.34E-07
Sr-89	1.98E-08	Te-129	8.07E-16	U-236	7.28E-06
Sr-90	1.13E+01	Te-129m	1.26E-15	U-238	1.86E-06
Y-90	1.16E+01	Cs-134	6.25E-02	Np-236	6.55E-12
Y-91	3.61E-07	Cs-135	1.09E-06	Np-237	3.32E-06
Zr-93	4.23E-04	Cs-137	5.90E-01	Pu-236	2.31E-05
Zr-95	3.80E-06	Ba-137m	5.58E-01	Pu-237	1.69E-15
Nb-94	2.05E-07	Ce-141	1.35E-14	Pu-238	2.81E-01
Nb-95	8.00E-06	Ce-142	3.58E-09	Pu-239	2.64E-03
Nb-95m	4.69E-08	Ce-144	3.70E+00	Pu-240	1.68E-03
Tc-99	9.05E-04	Pr-144	3.70E+00	Pu-241	3.17E-01
Ru-103	4.13E-12	Pr-144m	4.45E-02	Pu-242	2.32E-06
Ru-106	5.48E-01	Nd-144	1.81E-13	Am-241	4.05E-03
Rh-103m	4.29E-12	Pm-147	9.05E+00	Am-242	5.35E-06
Rh-106	5.76E-01	Pm-148	2.60E-14	Am-242m	5.38E-06
Pd-107	3.43E-06	Pm-148m	3.78E-13	Am-243	2.16E-06
Ag-110m	4.90E-03	Sm-147	7.35E-10	Cm-242	1.31E-05
Cd-113	1.42E-17	Sm-148	2.13E-15	Cm-243	2.08E-06
Cd-115m	3.44E-13	Sm-149	6.56E-16	Cm-244	6.10E-05
Sn-121m	1.12E-05	Sm-151	9.15E-02	Cm-245	2.49E-09
Sn-123	9.92E-05	Eu-152	1.39E-03	Cm-246	1.99E-10
Sn-126	5.63E-05	Eu-154	2.34E-01	Cm-247	2.44E-16
Sb-124	2.68E-11	Eu-155	1.79E-01	Cm-248	2.55E-16
Total Activity		4.33E+01 Ci/lb			

Table 5.5-3a
Shielding Design Bases - Radionuclide Composition of Glass from Sludge Plus Supernate

Isotope	Activity, Ci/lb	Isotope	Activity, Ci/lb	Isotope	Activity, Ci/lb
Cr-51	2.76E-20	Sb-125	2.58E-01	Tb-160	3.48E-10
Co-60	5.30E-02	Sb-126	6.55E-07	Tl-208	3.26E-07
Ni-59	4.31E-04	Sb-126m	4.68E-05	U-232	2.64E-05
Ni-63	5.35E-02	Te-125m	6.05E-02	U-233	3.14E-09
Se-79	4.13E-05	Te-127	2.64E-05	U-234	8.30E-05
Rb-87	2.75E-09	Te-127m	2.70E-05	U-235	2.76E-07
Sr-89	1.64E-08	Te-129	6.71E-16	U-236	6.01E-06
Sr-90	9.33E+00	Te-129m	1.04E-15	U-238	1.54E-06
Y-90	9.58E+00	Cs-134	1.11E-01	Np-236	5.41E-12
Y-91	2.98E-07	Cs-135	2.47E-05	Np-237	2.74E-06
Zr-93	3.50E-04	Cs-137	1.07E+01	Pu-236	1.91E-05
Zr-95	3.14E-06	Ba-137m	1.02E+01	Pu-237	1.34E-15
Nb-94	1.69E-07	Ce-141	1.11E-14	Pu-238	2.32E-01
Nb-99m	3.88E-08	Ce-144	3.05E+00	Pu-240	1.39E-03
Tc-99	7.52E-04	Pr-144	3.05E+00	Pu-241	2.63E-01
Ru-103	3.43E-12	Pr-144m	3.68E-02	Pu-242	1.92E-06
Ru-106	4.56E-01	Nd-144	1.49E-13	Am-241	3.35E-03
Rh-103m	3.54E-12	Pm-147	7.48E+00	Am-242	4.42E-06
Rh-106	4.76E-01	Pm-148	2.15E-14	Am-242m	4.45E-06
Pd-107	2.83E-06	Pm-148m	3.12E-13	Am-243	5.17E-06
Ag-110m	4.05E-03	Sm-147	6.07E-10	Cm-242	1.09E-05
Cd-113	1.18E-17	Sm-148	1.76E-15	Cm-243	1.72E-06
Cd-115m	2.84E-13	Sm-149	5.41E-16	Cm-244	5.04E-05
Sn-121m	9.24E-06	Sm-151	7.55E-02	Cm-245	2.06E-09
Sn-123	8.20E-05	Eu-152	1.15E-03	Cm-246	1.64E-10
Sn-126	4.65E-05	Eu-154	1.93E-01	Cm-247	2.02E-16
Sb-124	2.22E-11	Eu-155	1.48E-10	Cm-248	2.11E-16
Total Activity		5.58E+01 Ci/lb			

Table 5.5-3b
Shielding Design Bases - Radionuclide Composition of Glass from Sludge Plus Supernate (Maximum Projected Glass Product for GWSB #2[a])

Isotope	Activity, Ci/lb of glass	Isotope	Activity, Ci/lb of glass
Co-60	1.81 E-01	Pm-147	1.23E+00
Ni-59	4.24E-04	Eu-154	4.26E-01
Ni-63	0.00E+00	Th-232	2.39E-07
Se-79	2.34E-04	U-232	9.31E-08
Sr-90	1.93E+01	U-233	8.33E-06
Y-90	1.93E+01	U-234	2.05E-05
Nb-94	0.00E+00	U-235	1.52E-07
Tc-99	3.96E-03	U-236	1.91E-06
Ru-106	1.19E-03	U-238	1.31E-05
Rh-106	1.19E-03	Np-237	8.59E-06
Sb-125	5.74E-02	Pu-238	1.50E-00
Sn-126	2.14E-04	Pu-239	1.24E-02
Cs-134	5.71E-03	Pu-240	8.46E-03
Cs-135	2.65E-06	Pu-241	8.84E-01
Cs-137	1.59E+00	Pu-242	2.81E-05
Cs-137 [b]	1.53E+01	Ingrown Am-241	3.85E-02
Ba-137m	1.50E+00	Am-241	1.91 E-02
Ba-137m [b]	1.45E+01	Am-242m	3.30E-05
Ce-144	4.56E-04	Cm-244	4.72E-01
Pr-144	4.56E-04	Cm-245	3.76E-05

a Corrected Maximum Projected Isotopic Loading for GWSB #2, CBU-WSE-2006-00032 (Ref. 51)
b From Supernate

Table 5.5-4
Shielding Design Bases - Radionuclide Composition of ARP Streams

Isotope	LWPT	LWHT
	Activity Ci/gal	
Co-60	7.49E-02	1.58E-03
Sr-90	2.02E+01	4.27E-01
Y-90	2.08E+01	4.38E-01
Ru-106	9.98E-01	2.10E-02
Rh-106	1.00E+00	2.11E-02
Sb-125	3.66E-01	7.71E-03
Cs-134	7.04E-02	1.48E-03
Cs-137	1.77E+00	1.11E+00
Ba-137m	1.68E+00	1.05E+00
Ce-144	4.36E+00	9.18E-02
Pr-144	4.36E+00	9.18E-02
Pm-147	1.07E+01	2.25E-01
Eu-154	2.74E-01	5.76E-03
Pu-238	6.49E-01	1.37E-02
Pu-239	5.70E-03	1.80E-04
Pu-240	3.80E-03	9.34E-05
Pu-241	7.29E-01	1.56E-02
Am-241	1.17E-02	7.11E-03
Cm-244	4.69E-02	9.88E-04

Table 5.5-4a Shielding Design Bases - Radionuclide Composition of SEFT

Isotope	SEFT Activity Ci/gal
Co-60	
Sr-90	
Y-90	
Ru-106	
Rh-106	
Sb-125	
Cs-134	
Cs-137	1.65E+01
Ba-137m	1.56E+01
CE-144	
Pr-144	
Pm-147	
Eu-154	
Pu-238	
Pu-239	
Pu-240	
Pu-241	
Am-241	
Cm-244	

Table 5.5-5 through 5.5-14 Deleted

Table 5.5-15
Isotopic Concentration in the Zone 1 HVAC Exhaust
(Flowstream 131)

ISOTOPE	CONCENTRATION (Ci/ft^3)	ISOTOPE	CONCENTRATION (Ci/ft^3)
H-3	4.26E-11	Cs-134	1.05E-13
C-14	3.34E-11	Cs-135	2.33E-17
Co-60	9.48E-16	Cs-137	1.02E-11
Ni-59	1.10E-17	Ba-137m	2.01E-13
Ni-63	1.37E-15	Ce-142	5.29E-23
Se-79	1.37E-17	Ce-144	5.46E-14
Rb-87	9.10E-22	Pr-144	5.46E-14
Sr-89	4.28E-22	Pr-144m	6.58E-16
Sr-90	2.43E-13	Nd-144	2.67E-27
Y-90	1.47E-13	Pm-147	1.34E-13
Y-91	4.58E-21	Pm-148m	5.58E-27
Zr-93	6.26E-18	Sm-147	1.09E-23
Zr-95	5.62E-20	Sm-148	3.15E-29
Nb-94	2.59E-21	Sm-149	9.69E-30
Nb-95	1.18E-18	Sm-151	1.35E-15
Nb-95m	6.93E-22	Eu-152	2.05E-17
Tc-99	2.49E-16	Eu-154	3.45E-15
Ru-103	5.63E-24	Eu-155	2.65E-15
Ru-106	7.48E-13	Tb-160	6.22E-24
Rh-106	1.37E-14	Tl-208	5.83E-21
Pd-107	1.55E-21	U-232	8.10E-19
Ag-110m	7.10E-17	U-233	9.64E-23
Cd-113	1.17E-30	U-234	2.55E-18
Cd-115m	2.81E-26	U-235	8.47E-21
Sn-121m	1.65E-19	U-236	1.85E-19
Sn-123	1.47E-18	U-238	4.72E-20
Sn-126	8.32E-19	Np-236	9.67E-26
Sb-124	3.96E-25	Np-237	4.91E-20
Sb-125	4.61E-15	Pu-236	4.66E-19
Sb-126	1.17E-20	Pu-238	5.66E-15
Sb-126m	8.37E-19	Pu-239	5.32E-17
Te-125m	2.00E-14	Pu-240	3.39E-17
Te-127	8.75E-18	Pu-241	6.39E-15
Te-127m	8.92E-18	Am-241	5.99E-17
Te-129m	3.30E-28	Cm-242	1.94E-19
I-129	1.28E-15		
TOTAL CONCENTRATION: 8.79E-11 Ci/ft^3			

NOTE: 1 Ci/ft^3 = 35.32 mCi/cc

Table 5.5-16

DWPF Radiation Zoning Scheme

ZONE	MAXIMUM DOSE RATE (mrem/hr)	ACCESS REQUIREMENTS FOR OPERATIONS
I	>100	Controlled Access
II	≤100	Controlled Access
III	<5.0	Intermittent Access
IV	≤0.5 (existing and new facilities)	Routine Access
V	<0.05	Unlimited Access

Table 5.5-17 Deleted

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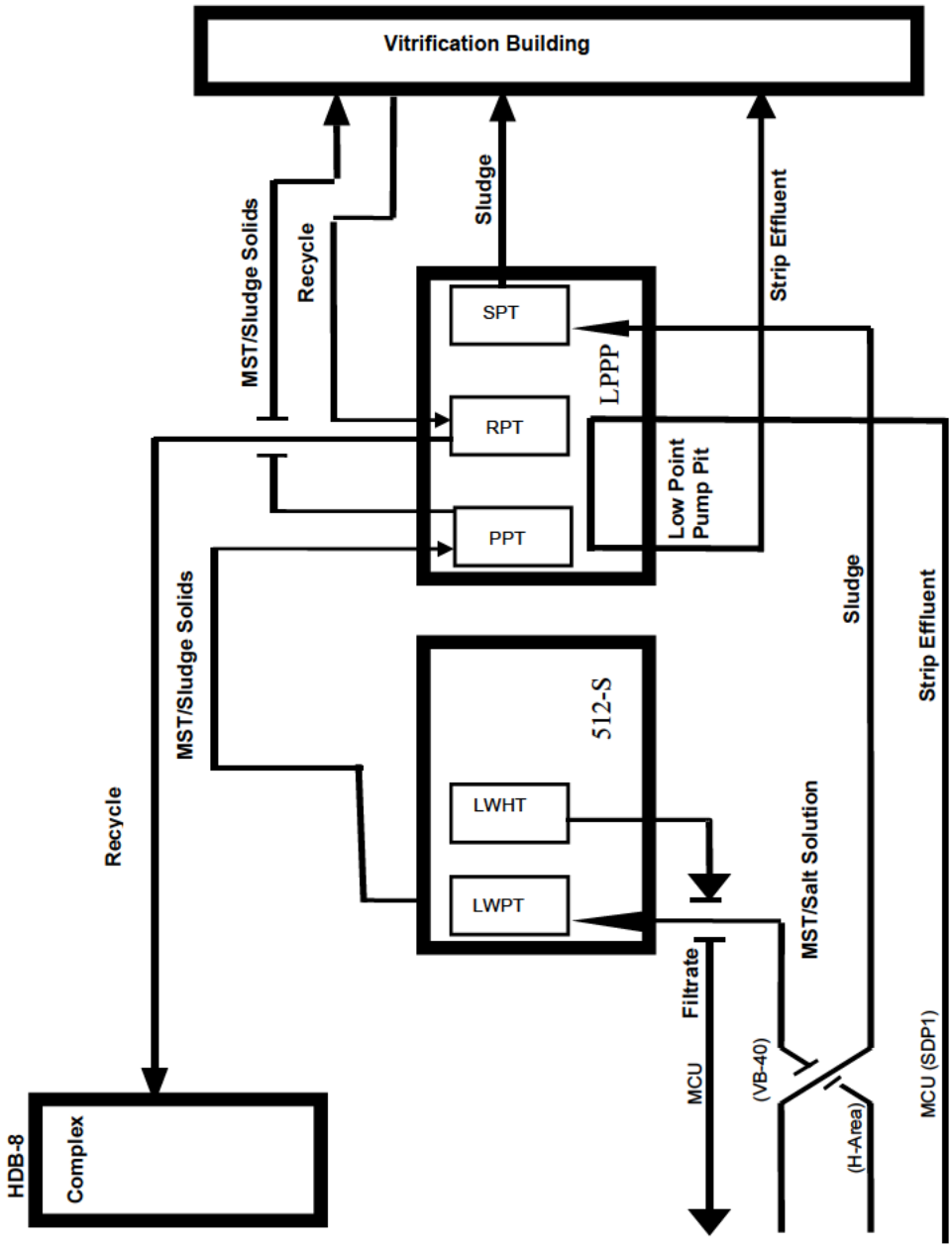

Figure 5.3-1 Interarea Transfer Lines – Layout

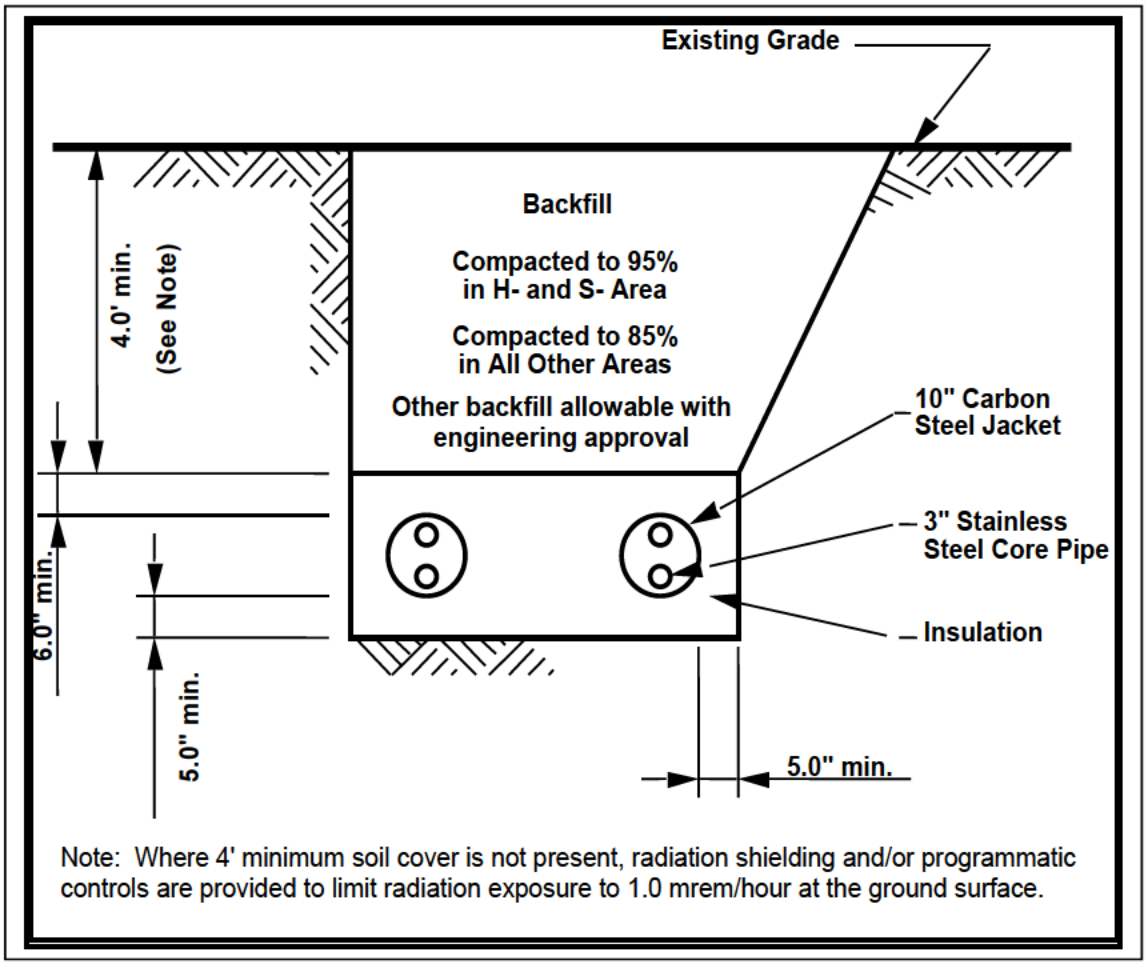

Figure 5.3-2 Interarea Transfer Line - Typical Section

Figure 5.3-3 Deleted

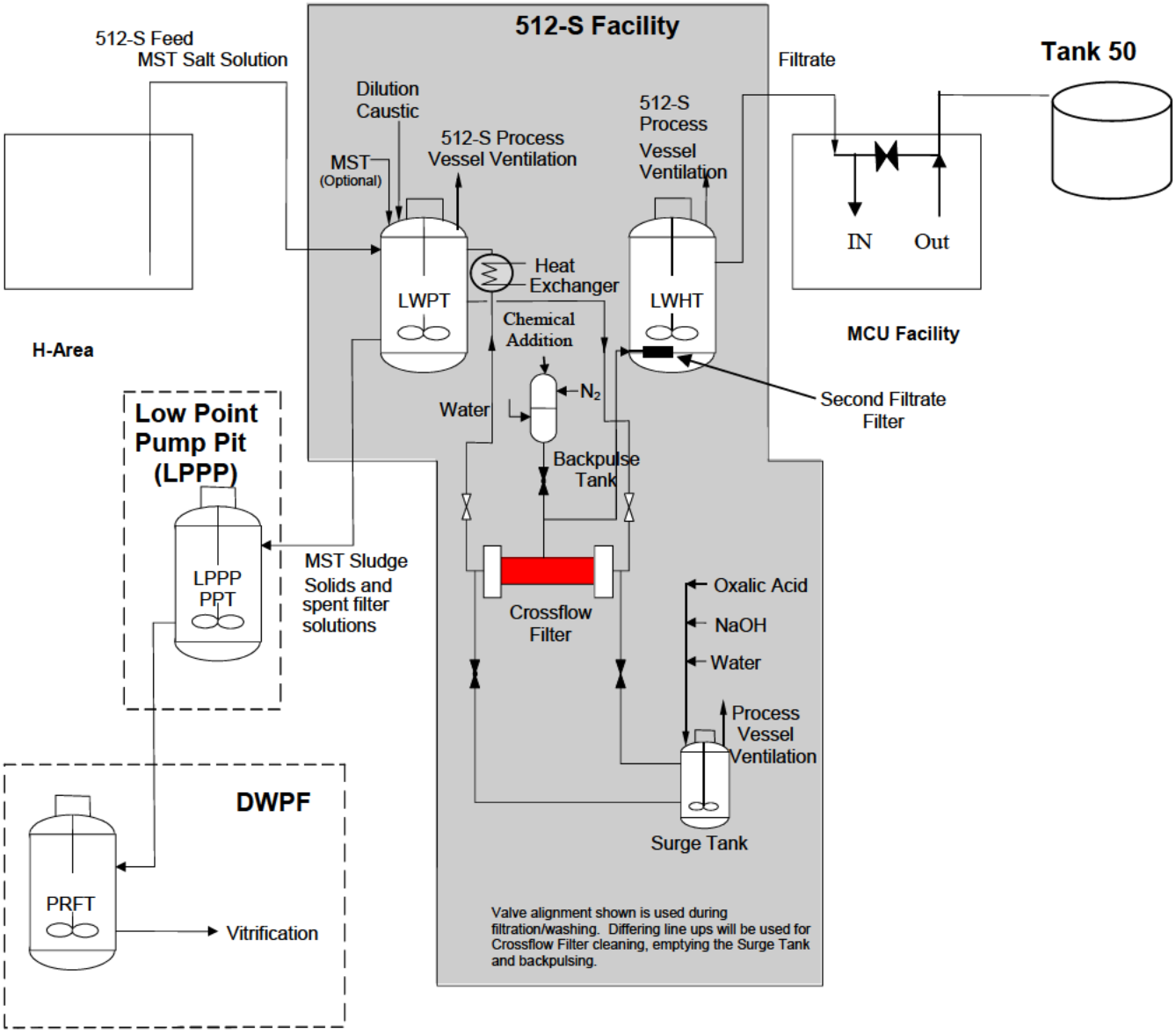

Figure 5.3-4 Actinide Removal Process

Figures 5.5-1 through 5.5-39 Deleted