SALT WASTE PROCESSING FACILITY

PROJECT FIRE HAZARDS ANALYSIS

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SUMMARY OF CHANGES

Revision No.	Date	Description of Change
0	07/25/08	Initial Issuance.
1	06/18/09	Revised per DMR-0767, add the analysis for the fire protection of the HEPA filters in the facility, and the justification of the methods used.
2	02/12/2015	Revise per DMR-2285. Required three-year revision cycle.
3	08/05/2019	Revise per DMR-4712, Document revision to address triennial revision. Complete re-write, no revision bars used.

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
ºC	degrees Celsius
°F	degrees Fahrenheit
ADS	Air Dilution System
AFF	Alpha Finishing Facility
AFP	Alpha Finishing Process
AHU	Air Handling Unit
ALARA	As Low As Reasonably Achievable
APA	Air Pulse Agitator
ASME	American Society of Mechanical Engineers
ASP	Alpha Strike Process
AST-A	Alpha Sorption Tank-A (TK-101)
AST-B	Alpha Sorption Tank-B (TK-221)
ASTM	American Society for Testing and Materials
BOBCalixC6	Calix[4]arene-bis(tert-octylbenzo-crown-6)
BNA	Baseline Needs Assessment
CCA	Cold Chemicals Area
CCTV	Closed-circuit Television
CFF	Cross-flow Filter
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
CLFL	Composite Lower Flammability Limit
CMMS	Computerized Maintenance Management System
CPA	Central Processing Area
Cs	Cesium
CSS	Clarified Salt Solution
CSSX	Caustic-side Solvent Extraction
D/C	Demand to Capacity Ratio
DCS	Distributed Control System
DG	Diesel Generator
DID	Defense-in-Depth
DOE	U.S. Department of Energy
DSS	Decontaminated Salt Solution
DSSHT	Decontaminated Salt Solution Hold Tank (TK-207)
DWPF	Defense Waste Processing Facility
ERO	Emergency Response Organization
FACP	Fire Alarm Control Panel
FEMA	Federal Emergency Management Agency
FFT-A	Filter Feed Tank-A (TK-102)
FFT-B	Filter Feed Tank-B (TK-222)
FHA	Fire Hazards Analysis
FM	Factory Mutual

LIST OF ACRONYMS AND ABBREVIATIONS

FSA	Facility Support Area
ft	Feet/Foot
ft^2	Square feet/foot
gpm	Gallons per minute
gpm/ft^2	Gallon per minute per square feet
H_2	Hydrogen
$H_2C_2O_4$	Oxalic Acid
HEPA	High-Efficiency Particulate Air
HF	Hydrogen Fluoride
HNO_3	Nitric Acid
HPR	Highly Protected Risk
HVAC	Heating, Ventilating, and Air Conditioning
IBC	International Building Code
ICD	Interface Control Document
IFC	International Fire Code
IST	Intermediate Storage Tank (TK-220)
IT	Information Technology
kg	Kilogram
kV	Kilovolt
kVA	Kilovolt-ampere
lb	Pound
lb/ft^2	Pounds per Square Foot
LSC	Life Safety Code (NFPA 101)
M	Molar
MCFL	Maximum Credible Fire Loss
ml	Milliliter
MPFL	Maximum Possible Fire Loss
MPFS	Most Probable Fire Scenario
MST	Monosodium Titanate
NaOH	Sodium Hydroxide
NFPA	National Fire Protection Association
NGS	Next Generation Solvent
NPH	Natural Phenomena Hazard
P&VG	Pump and Valve Gallery
PA	Plant Air
PBVS	Process Building Ventilation System
PC	Performance Category
PCAR	Programmatic Compliance Assessment Report
PMVS	Pulse Mixer Ventilation System
PP	Project Procedure
psi	Pounds per square inch
PVVS	Process Vessel Ventilation System
SC	Safety Class

LIST OF ACRONYMS AND ABBREVIATIONS

SEHT	Strip Effluent Hold Tank (TK-205)
SHT	Solvent Hold Tank (TK-202)
SPF	Saltstone Production Facility
Sr	Strontium
SRS	Savannah River Site
SRSOC	SRS Operations Center
SS	Safety Significant
SSC	Structure, System, and Component
SSRT	Sludge Solids Receipt Tank (TK-104)
SWPF	Salt Waste Processing Facility
TBP	Tri-n-butyl Phosphate
TOA	Trioctylamine
TTF	Temporary Tank Farm
UL	Underwriters Laboratory
UPS	Uninterruptible Power Supply
VAC	Volts Alternating Current
WSRC	Washington Savannah River Company
wt%	Weight Percent
WTE	Waste Transfer Enclosure

EXECUTIVE SUMMARY

This Fire Hazards Analysis (FHA) is for the Salt Waste Processing Facility (SWPF) in J-Area at Savannah River Site (SRS).

The SWPF Project is currently in the commissioning phase. This analysis is based on the installed condition. Design changes during commissioning are subject to further analysis and revision of this document. Maximum possible fire loss (MPFL) and maximum credible fire loss (MCFL) scenarios are also based on current conditions.

This analysis shows that the overall level of fire protection for the SWPF is sufficient for its mission as a radioactive waste processing and treatment facility. Monetary loss potential is minimized to meet U.S. Department of Energy (DOE) requirements. There are no life safety issues, and all programmatic requirements have been met by the provisions of the fire protection systems and fire protection programs that are in place.

Open Items have been identified in Section 4.2. There are some system and procedural items that have been identified and are being corrected. These items do not affect the safe operation of the SWPF. These items are noted in this analysis to ensure that efforts develop around the stated requirements.

1.0 INTRODUCTION

This report documents the FHA for the SWPF, located in J-Area at SRS adjacent to the southeast corner of S-Area. The SWPF will receive high-Curie salt waste removed from various salt waste source tanks, which are blended and staged in the H-Area Feed Tank (TK-49). These wastes are then processed, separating the actinides, strontium (Sr), and Cesium (Cs) from the waste. The separated materials will be sent to the Defense Waste Processing Facility (DWPF) with the remaining salts sent to the Saltstone Facility for onsite disposal. The purpose of this analysis is to evaluate the fire protection and life safety features of the SWPF, and to determine if the fire protection objectives of DOE O 420.1B, *Facility Safety*[1], are met through engineered features or fire protection program administrative features. The following DOE O 420.1B[1] objectives are addressed and satisfied by this analysis:

Minimize potential for the occurrence of a fire or related event;

Minimize the potential for a fire that causes an unacceptable onsite or offsite release of hazardous and radioactive material that will threaten the health and safety of employees, the public, or the environment;

Minimize the potential for vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards;

Minimize the potential for property losses from fire and related events exceeding defined limits; and

Minimize the potential for critical process controls and Safety Class (SC) systems being damaged, as a result of a fire or related events (SWPF has no SC systems).

The SWPF is classified as a Non-reactor Hazard Category 2 Nuclear facility, consistent with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*[2]. Therefore, a general fire protection design analysis has been prepared. The intent of the general fire protection design analysis is to determine whether DOE fire safety objectives are met. The analysis is made by using those parameters established in Appendix A, Section 2 of 10 Code of Federal Regulations (CFR) 851, *Worker Safety and Health Program*[3]. The analysis determines the special fire prevention and protection features and controls required to achieve a level of highly protected risk (HPR) fire protection that limits damage to an acceptable level. This FHA analyzes the SWPF, based on the final design and completed construction. S-SAR-J-00002, *SWPF Documented Safety Analysis*[4], was used as a tool for developing the process descriptions and nuclear safety determinations and as a source of safety significant (SS) fire controls. This analysis also evaluates the fire protection and life safety features of the facility, identifies safety and monetary loss concerns, and evaluates code compliance.

The Administration Building, 704-J, and other smaller structures associated with this facility are discussed in this FHA. The J-Area Warehouse, Building 763-S, is discussed in F-FHA-J-00002, *SWPF J-Area Warehouse Fire Hazards Analysis*[5].

1.1 Methodology

The FHA follows the methodology provided in SWPF Project Procedure (PP) PP-EN-5022, *Preparation of Fire Hazards Analysis*[6]. This guideline provides a standard format and outline for all FHAs at SWPF meeting the requirements of DOE O 420.1B[1].

DOE O 420.1B[1] specifies design requirements and performance objectives for items identified as SC items. SC structures, systems, and components (SSCs) are defined by 10 CFR 830, *Nuclear Safety Management*[7], as SSCs, including portions of process systems, whose preventive or mitigative function is necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses. SWPF has no SC SSCs.

This analysis was developed by using a graded approach. This graded approach allows the appropriate level of resources to be applied to areas of the analysis based on the complexity of the process, level of hazards, relative risk, and consequences of fire.

The FHA is based on the final design. The SWPF Project is currently in the commissioning phase.

This FHA contains Open Items that are listed in Section 4.2. This analysis is required to be reviewed periodically as required by DOE Orders and Standards. It will also be reviewed as part of the SWPF start-up activities (PP-EN-5022[6]). All open items will be closed prior to hot operations.

1.2 Special Criteria

No special evaluation criteria are associated with SWPF.

1.3 Assumptions

Cable in conduit is not considered by this analysis to be a combustible, and thus was not included in fire loading characterizations. Other combustibles are maintained in accordance with PP-EN-5043, *Combustible Load and Ignition Source Control*[6]. Nitric acid concentrations and temperatures are maintained well below that required to create a red oil explosion if it came into contact with a mixture of tri-n-butyl phosphate (TBP) transferred from the H-Tank Farm.

1.4 Definitions

Where possible, DOE-defined terms are used in the text of this document. PP-EN-5022[6] should be referenced if there are any questions regarding fire safety terms.

2.0 FACILITY DESCRIPTION

The overall SWPF mission is to separate and concentrate the radioactive Cs, Sr, and actinide contaminants contained in the high-Curie salt solutions removed from the salt waste tanks in the F- and H-Area Tank Farms at SRS. The SWPF will occupy approximately 10.7 acres and is located in J-Area, east of the Low-point Pump Pit (Building 511-S) and southeast of the DWPF. (see Figure 2-1 through Figure 2-6).

Figure 2-1. North Site Plan – Tie-in to S Area Water Supply

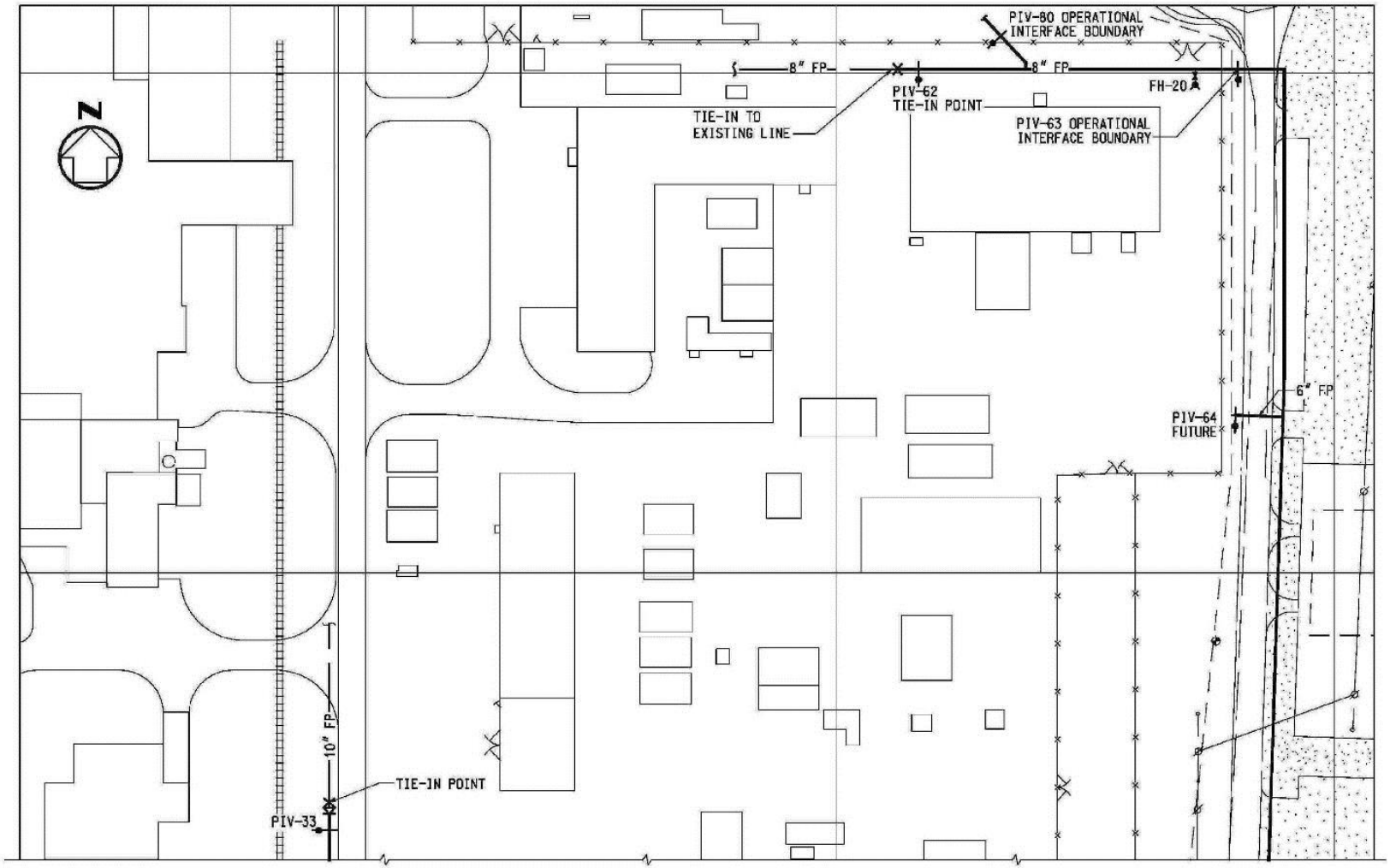


Figure 2-2. South Site Plan – SWPF Water Supply

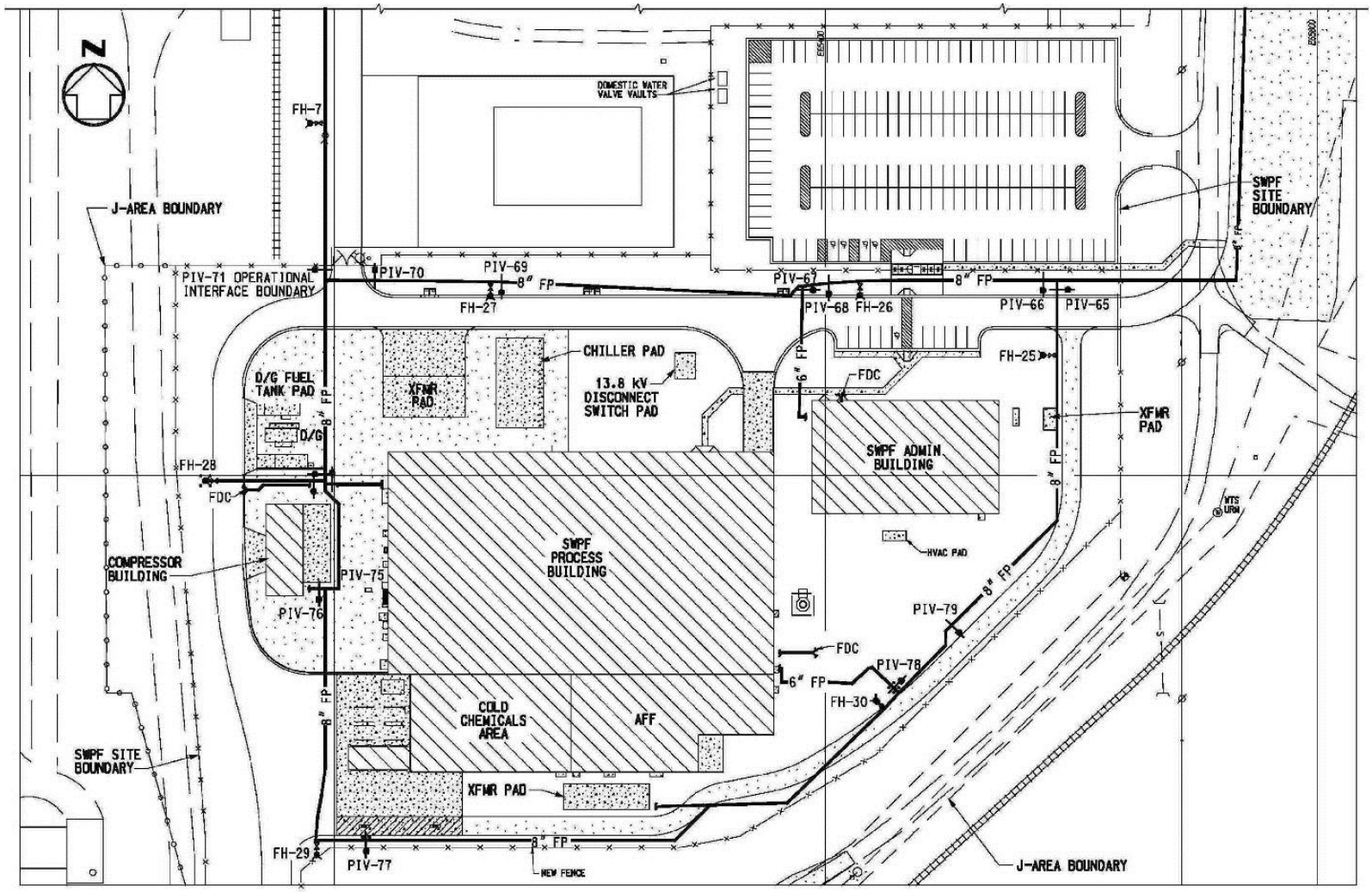


Figure 2-2a. Partial South Site Plan with Temporary Tank Farm and Next Generation Solvent Building

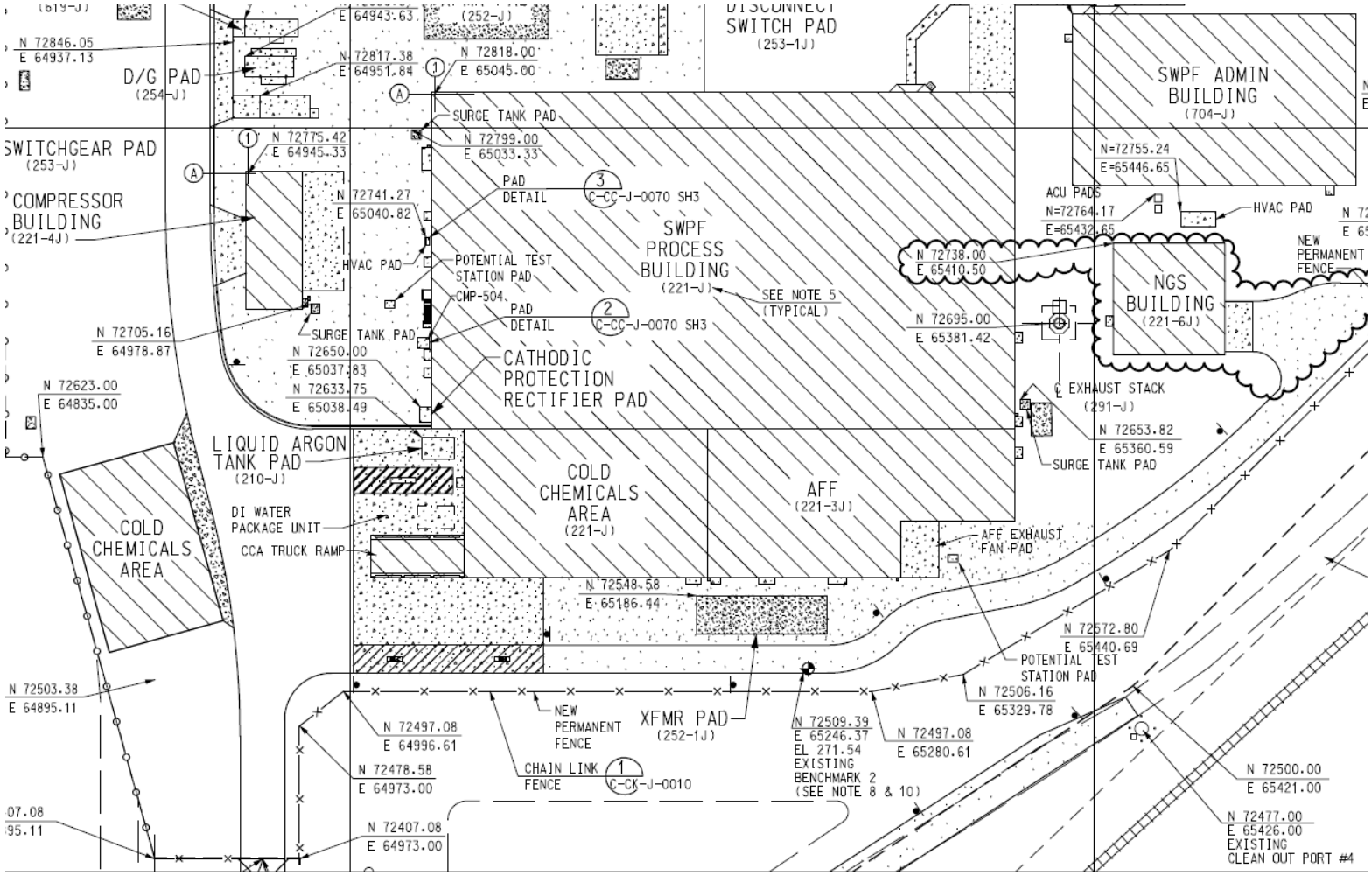


Figure 2-3. Building Plan – Fire Areas (Elevation 100-0 ft)

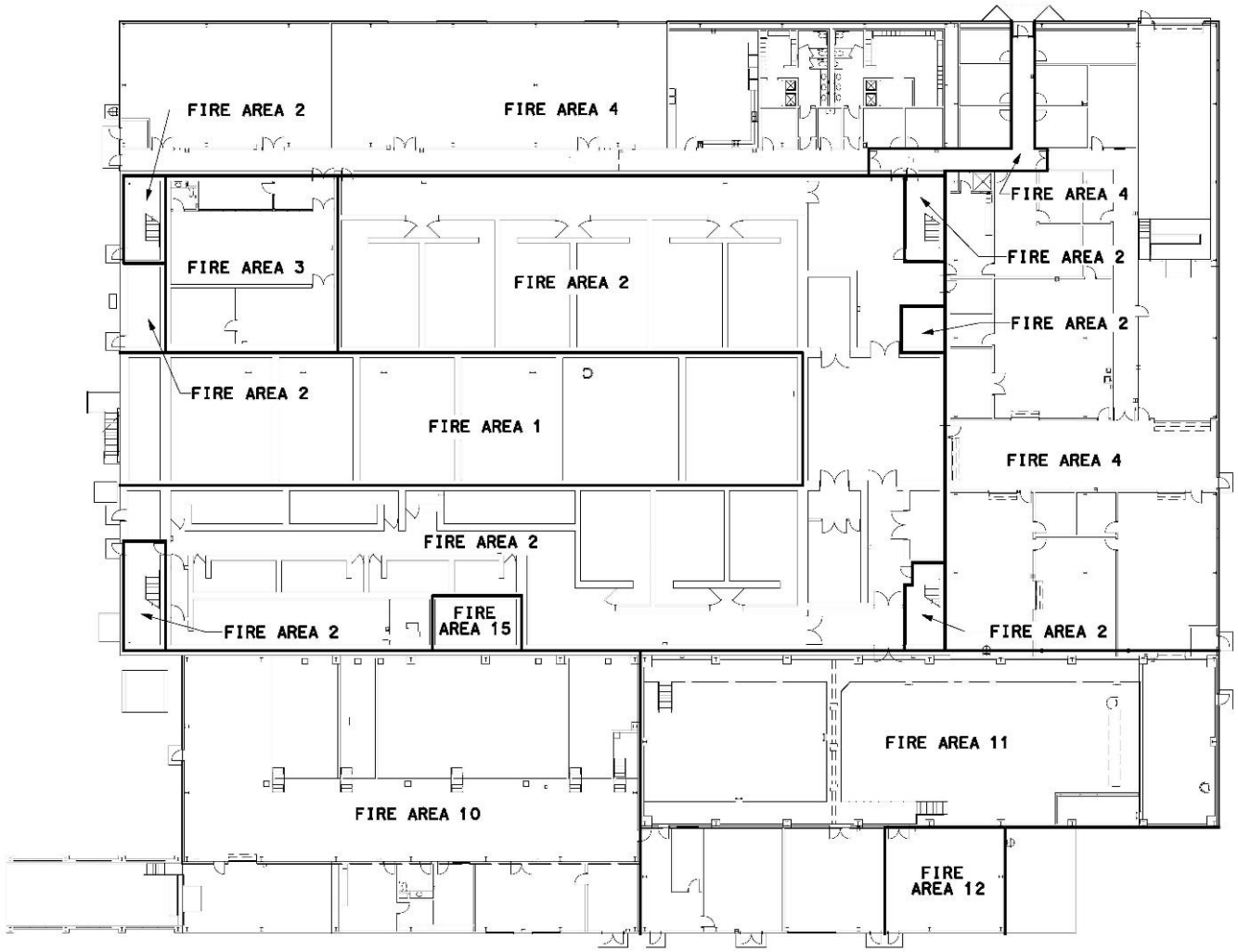


Figure 2-4. Building Plan – Fire Areas (Elevation 116-0 ft)

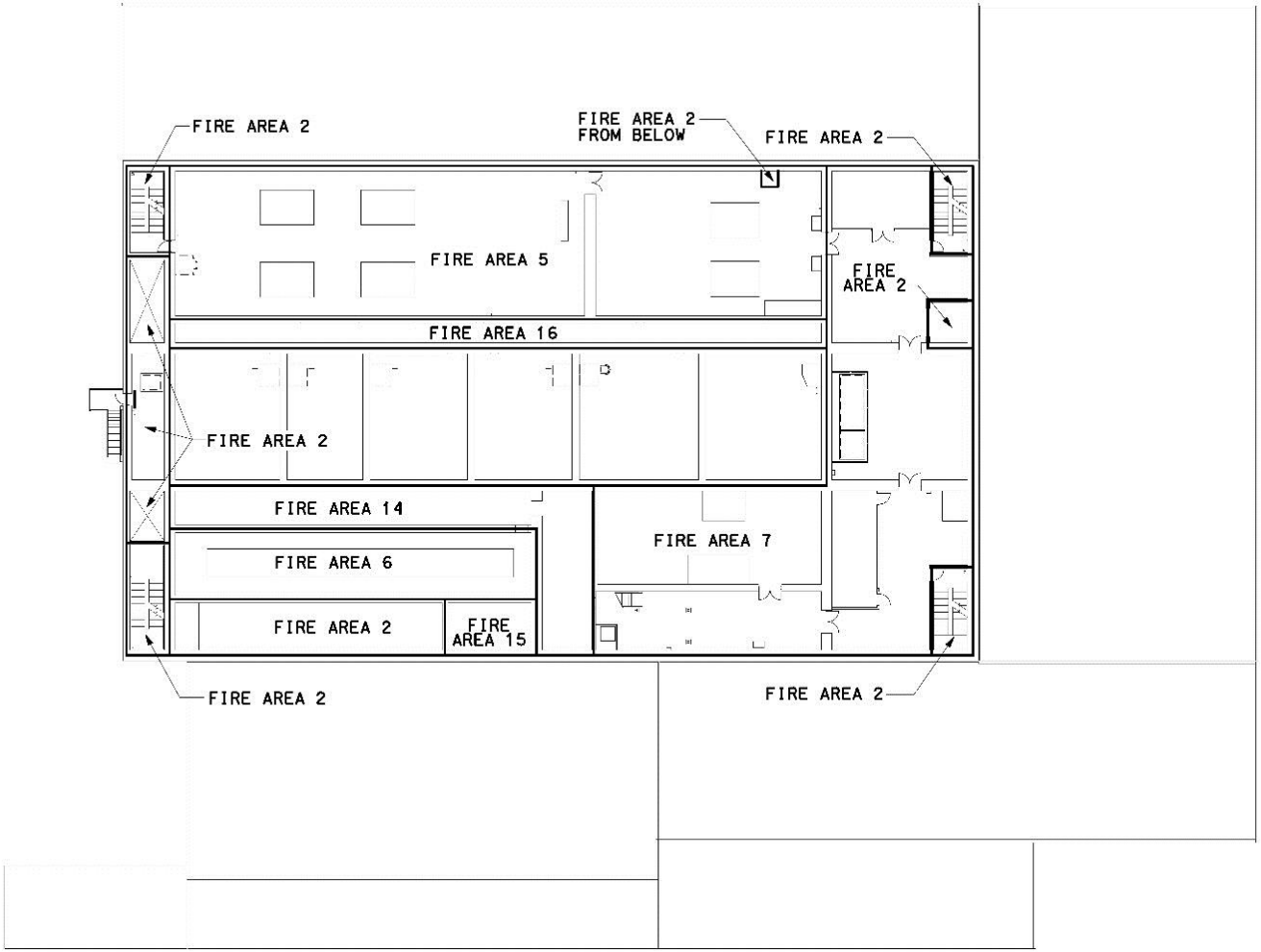


Figure 2-5. Building Plan – Fire Areas (Elevation 124-0 ft)

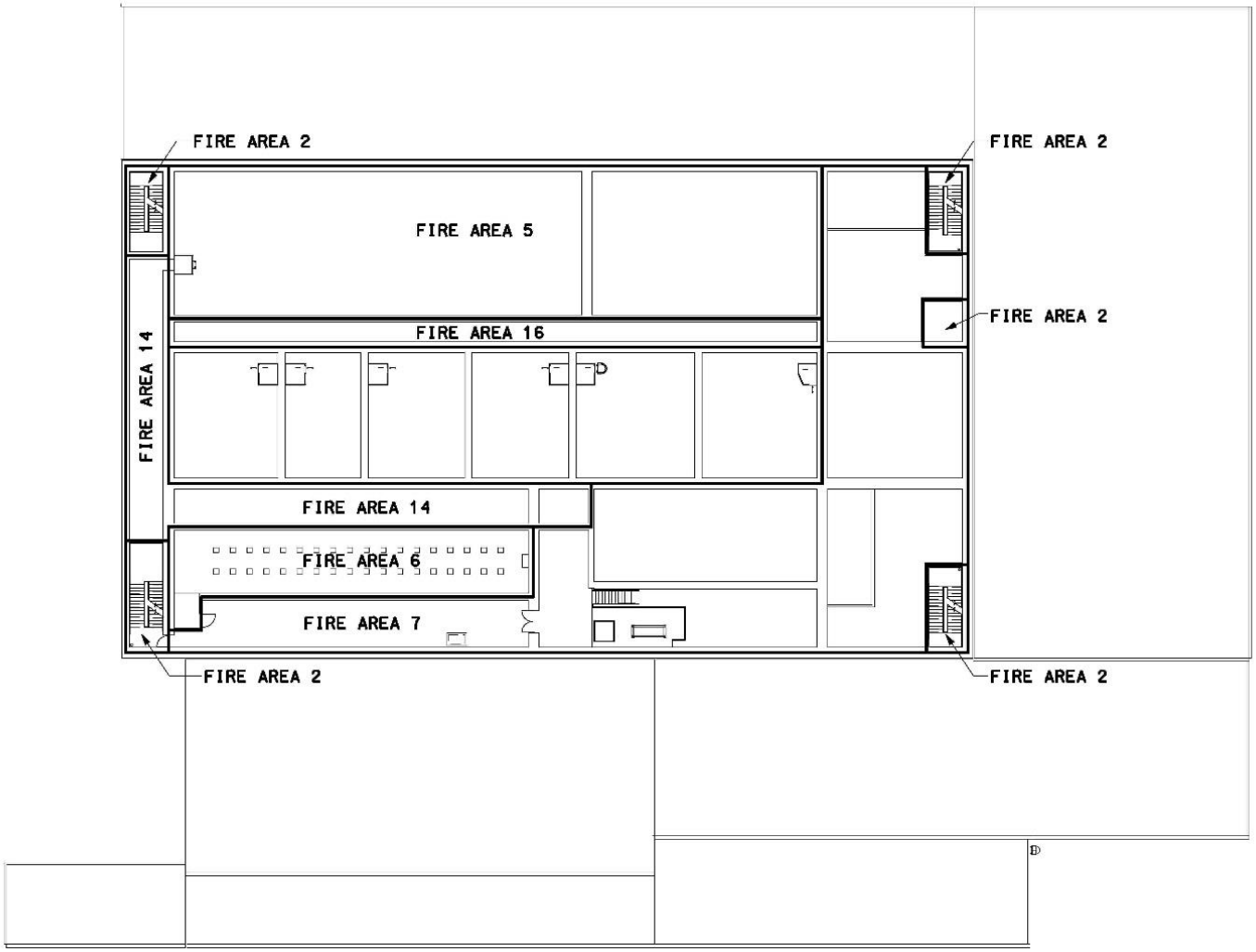


Figure 2-6. Building Plan – Fire Areas (Elevation 139-0 ft)

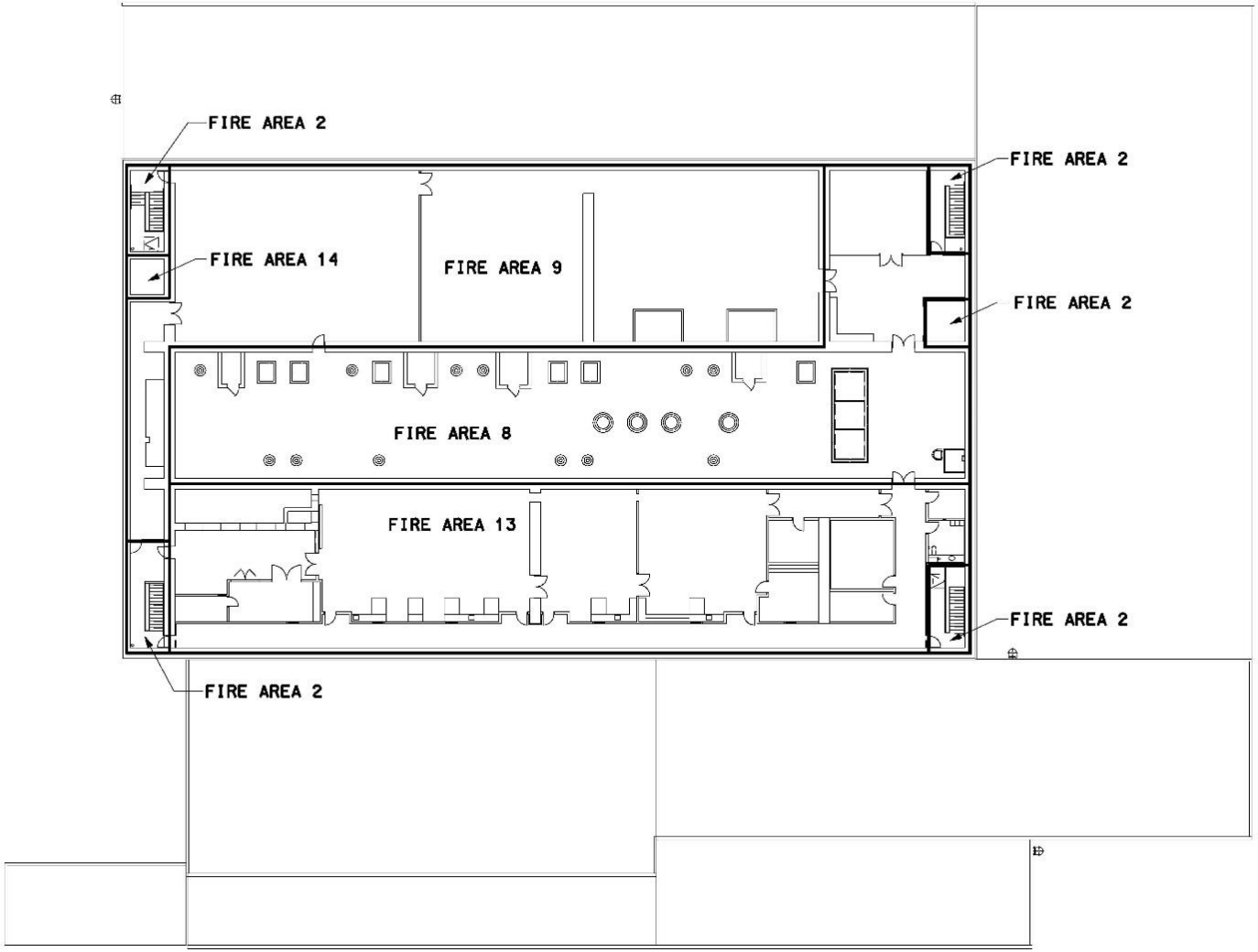


Figure 2-1 (North Site Plan) and Figure 2-2 (South Site Plan) depict the general site conditions showing the underground fire protection lines from S-Area feeding J-Area. Figure 2-2a is a partial south site plan (from C-CX-J-0001, *SWPF Civil Site Plot Plan (U)*[8]) showing the Temporary Tank Farm (TTF) structure and the Next Generation Solvent (NGS) building. Figure 2-3, depicts the 100.0-foot (ft) elevation (ground level) and associated fire areas. Figure 2-4 depicts the 116.0-ft elevation and associated fire areas. Figure 2-5 depicts the 124.0-ft elevation and associated fire areas. Figure 2-6 depicts the 139.0-ft elevation and associated fire areas.

2.1 General Description and Location

The SWPF consists of several structures including the Process Building (which includes the Central Processing Area [CPA]), the Alpha Finishing Facility (AFF), the Cold Chemicals Area (CCA), and the Facility Support Area (FSA). Additional structures include the Administration Building, Diesel Generator (DG) and fuel tank, Compressor Building, and transformers on pads. The focus of this Project FHA is on the Process Building, with additional information on the other buildings.

The SWPF structures are designed to meet Natural Phenomena Hazards (NPH) objectives, based on criteria provided by DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*[9], and DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*[10]. The Performance Categories (PCs) for the SWPF structures range from PC-1 to PC-3. The Process Building consists of a central multi-level concrete structure and three single-level braced-frame steel structures adjacent to the central concrete portion. The central concrete structure is called the CPA and the three surrounding steel structures are the FSA, CCA, and AFF.

The CPA of the SWPF Process Building is designed to PC-3 criteria. The CCA, FSA, and AFF are designed to PC-1 criteria. See the Architectural drawings, A-A1-J-0001, *SWPF Process Building Architectural – Life Safety Occupancy Plan at Elevation 100'-0"*[11]*;* A-A1-J-0002, *SWPF Processing Building Architectural – Life Safety Occupancy Plan at Elevation 116'-0"*[12]; A-A1-J-0003, *SWPF Process Building Architectural – Life Safety Occupancy Plan at Elevation 124'-0"*[13], and A-A1-J-0004, *SWPF Process Building Architectural – Life Safety Occupancy Plan at Elevation 139'-0"*[14], for actual floor areas of this building.

The AFF is a steel-framed structure on the south side of the CPA. This building contains two diked process areas, an Electrical Room, one Air Handler Room, and one High-Efficiency Particulate Air (HEPA) Filter Room. The HEPA Filter Room is separated from the AFF by a two-hour fire barrier, as recommended by DOE-STD-1066-99, *Fire Protection Design Criteria*[15]. The dikes, Heating, Ventilating, and Air Conditioning (HVAC) Rooms, and Electrical Room are enclosed by insulated steel siding and roofing, supported by a structural steel frame.

The CCA is a steel-framed structure on the south side of the CPA and west of the AFF. It is separated from the AFF by a two-hour fire barrier. This building also contains diked chemical storage areas, an Electrical Room, and an HVAC Room. The dikes, HVAC Rooms, and Electrical Room are enclosed by insulated steel siding and roofing, supported by a structural steel frame.

The FSA is a steel-framed structure on the north and east sides of the CPA. It is separated from the AFF by a two-hour fire barrier. This building contains an Electrical Room, Mechanical Room, locker rooms, and offices. The rooms are enclosed by insulated steel siding and roofing, supported by a structural steel frame.

The Administration Building, provided for administrative support services (including office space, conference room, Document Control area, etc.), and the Compressor Building, which provides compressed air for pneumatic instruments, are separate structures located in close proximity to the Process Building. A Chiller System is located on a pad. The DG is a self-contained unit that sits on a pad. The fuel tank sits on a separate pad beside the DG set.

The DG and fuel tank are designed for unprotected outdoor use. The DG unit is in compliance with National Fire Protection Association (NFPA) 110, *Standard for Emergency and Standby Power Systems*[16]. The fuel tank is a double-walled tank.

The Administration Building is a single-story building constructed of non-combustible gypsum wall partitions, acoustic ceiling tile, carpet, sheet vinyl flooring, and ceramic tile, water-tight roofing and siding, aluminum windows, and exterior metal doors and frames. The building is 92'-6" x 152'-6" (see RCN-30070-SDC-061, *Administration Building Floor Plan*[17]).

The Compressor Building is a single-story structure. The roof construction consists of insulated metal panels over a structural steel roof framing system, with exhaust fans for ventilation. The building is approximately 31 x 75 x 24-ft-high (see drawing A-A2-J-0020, *SWPF Compressor Building Architectural Floor Plan at Elevation 100'-0"*[18], Sheet 1 of 2, and A-A2-J-0020, *SWPF Compressor Building Architectural Floor Plan at Elevation 100'-0"* [19], Sheet 2 of 2) and is provided with an overhead door and a personnel door.

The NGS Building is a single-story structure. The roof construction consists of insulated metal panels over a structural steel roof framing system, with exhaust fans for ventilation. The building is approximately 61 x 61 x 27-ft-high (see drawing A-A2-J-0022, *SWPF Next Generation Solvent Building Architectural Floor Plan at Elevation 98'-9"*[20]) and is provided with an overhead door and two personnel doors.

2.2 Classifications

The Building Code of Record is the 2003 edition of the IBC (IBC-2003, *International Building Code*[21]). The specific editions of the NFPA codes are referenced in this FHA and in P-DB-J-00004, *SWPF Balance of Plant Basis of Design*[22]. The SWPF is classified as follows:

1. S-SAR-J-00002[4] indicates that the SWPF is a Nonreactor Hazard Category 2 Nuclear Facility.
2. IBC-2003[21] – The SWPF Use and Occupancy classification is Factory Industrial (F-2) Low Hazard for the FSA and High Hazard (H-4) for the CCA, CPA, and AFF due to health hazards. The CPA and AFF will potentially contain hazardous levels of various chemicals. The AFF contains low level radioactive material and resulting low gamma radiation such that this portion of the facility was permitted to be constructed as a steel frame building rather than a

concrete building (see S-SAR-J-00002[4]). The automatic sprinkler systems permit the CCA to be classified as H-4, which permits the CCA to have an unlimited quantity of Class 1 oxidizers (i.e., 40 weight percent [wt%] nitric acid [HNO_3] and lower) per Table 307.7(1), Note f of IBC-2003[21]. The chemical quantities in CCA exceed the Maximum Allowable Quantity per Control Area (threshold limits for area classification) in Table 307.7(2) of IBC-2003[21]; therefore, the CCA is classified as an H-4 Occupancy and is required to have Type II (111) construction, per Table 503 and Table 601 of IBC-2003[21].

3. IBC-2003[21] – The construction classification for all the areas of the SWPF is Type IIA per Table 503 of IBC-2003[21]. This construction is characterized by non-combustible materials protected to achieve a one-hour fire rating. The sprinkler credit is taken for an area increase and to allow an unlimited quantity of Class 1 oxidizers in CCA. Type IIA construction of IBC-2003[21] equates to Type II (111) construction in NFPA 220, *Standard on Types of Building Construction*[23]. Exposed structural steel above 20 ft is not required to be protected in FSA since it is an F-2 Occupancy according to Table 601, Note c.1 of IBC-2003[21]. The rating of the construction cannot be reduced since the sprinkler credit has already been used for other reasons as noted in Table 601, Note d of IBC-2003[21]. Fire Areas are created by two-hour fire barrier walls as discussed in Section 3.2. Exposed structural steel supporting the two-hour fire barrier walls in AFF is protected by two-hour protection.

4. American National Standards Institute (ANSI)/NFPA 101, *Life Safety Code*[24] (LSC) (The American National Standards Institute has adopted the LSC, referenced throughout the FHA as NFPA 101) – Based on the quantities of solid and liquid combustibles, the hazard classification of the contents of SWPF is Ordinary Hazard Contents according to Section 6.2.2 of NFPA 101[24]. The Design Criteria Database lists the 2000 edition of NFPA 101, *Life Safety Code*[25]. However, this analysis uses the 2003 edition of NFPA 101, *Life Safety Code*[26], to coincide with the same year as the IBC. Code revisions usually clarify concepts and sometimes become more restrictive. This is considered conservative.

5. NFPA 13, *Standard for the Installation of Sprinkler Systems*[26] – The general design classification for sprinkler protection is Ordinary Hazard, Group 2.

6. NFPA 101[24] - The FSA is classified as a General Industrial Occupancy, while the CPA, CCA, and AFF are classified as a Special Purpose, Industrial Occupancy. The SWPF is expected to operate in a continuous production mode (24 hours per day, 7 days per week). The operational staff will consist of: Control Room and process operators, Engineering, Radiological Control, laboratory technicians, and maintenance and administrative support. Maximum probable occupancy for the Process Building is expected to be 75 persons.

2.3 Facility Operations and Processes

2.3.1 Process Description

The SWPF performs three basic radiochemical process operations. Figure 2-7 is a simplified Process Flow Diagram depicting the major process operations and flow streams. The Alpha Strike Process (ASP) is a batch process that utilizes monosodium titanate (MST) addition, followed by mixing and filtration, to remove actinides and Sr. This process also provides an option to perform

additional MST strikes on a filtered waste batch to optimize actinide and Sr removal and MST consumption. The ASP produces concentrated MST/sludge slurry containing actinides, Sr, and limited amounts of Tank Farm sludge carryover, which is sent to the DWPF. It also produces Cs-bearing clarified salt solution (CSS) that is sent to the second process operation or recycled to Alpha Sorption Tank-A (AST-A) (TK-101) for an additional MST strike.

In the ASP, the soluble actinides and Sr are sorbed onto MST particles in AST-A (TK-101). The resulting slurry containing the actinide- and Sr-loaded MST and entrained suspended solids (i.e., sludge from the Tank Farm waste tanks) is transferred to Filter Feed Tank-A (FFT-A) (TK-102), where it is concentrated by circulating the slurry through cross-flow filters (CFFs). The concentrated MST/sludge is transferred to the Sludge Solids Receipt Tank (SSRT) (TK-104) for a washing operation to reduce the sodium concentration followed by transfer to DWPF. The filtrate from the CFFs is the Cs-bearing CSS, which is sent to the Caustic-side Solvent Extraction (CSSX) process or returned to AST-A (TK-101) for an additional MST strike.

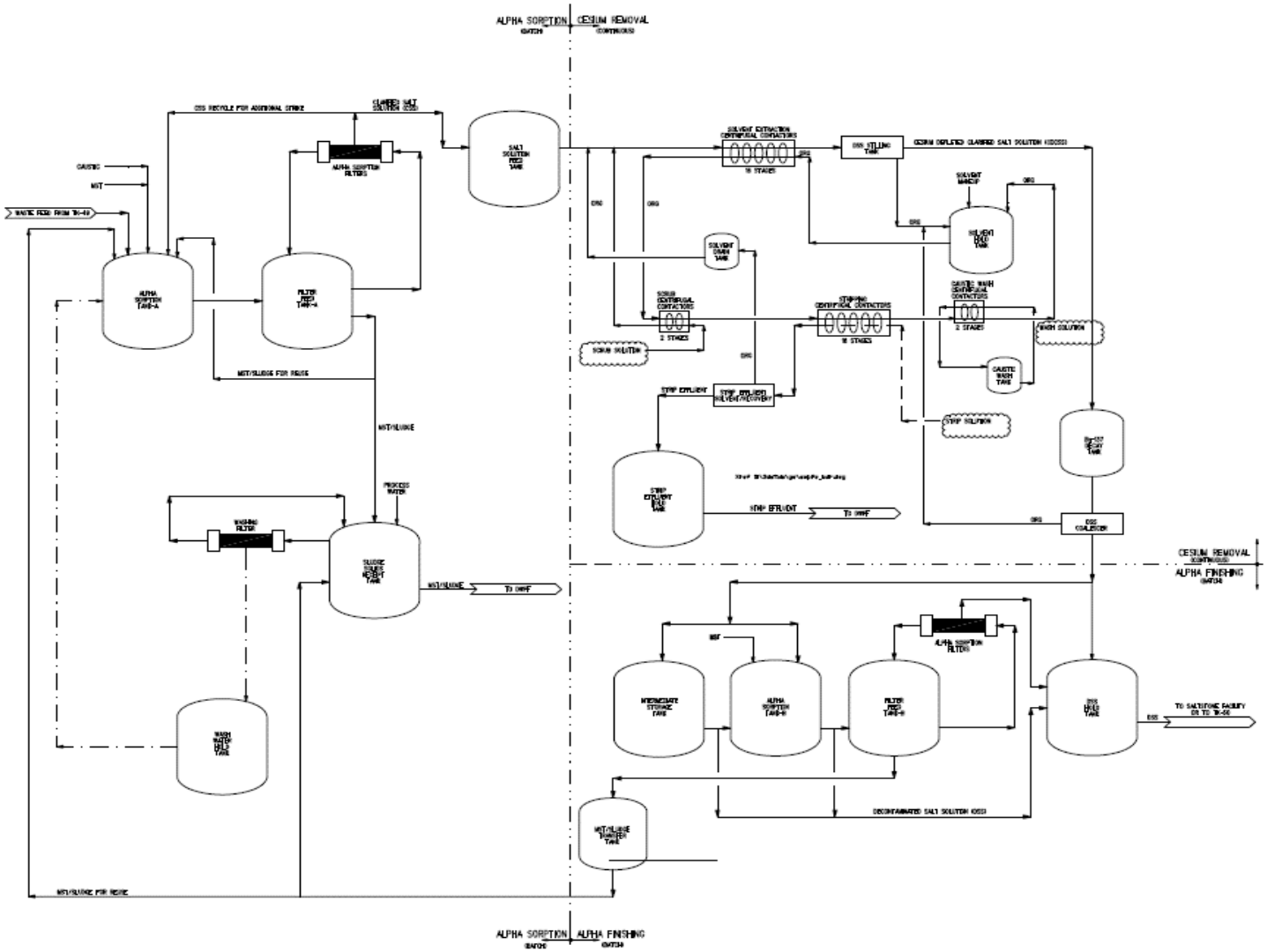
The second process operation, CSSX, removes Cs from the CSS in a continuous flow process. The CSSX process produces a concentrated Cs solution (strip effluent) that is sent to DWPF and a Cs-depleted decontaminated salt solution (DSS) that is ultimately sent to the Saltstone Production Facility (SPF).

The solvent used to extract the Cs in the CSSX process is a four-component mixture composed of a specially engineered extractant (Calix[4]arene-bis(tert-octylbenzo-crown-6) [BOBCalixC6]) at 0.007 Molar [M], a modifier (Cs-7SB) at 0.75M, a suppressant (trioctylamine [TOA]) at 0.003M, with the balance in Isopar L (diluent). The CSS (filtrate from the CFFs) is mixed counter-current with the solvent in the extraction stage centrifugal contactors. The Cs-depleted CSS is transferred to the AFP for transfer out of the facility or for further reduction of actinides and Sr.

The Cs-loaded solvent is scrubbed in centrifugal contactors with dilute (0.05M) HNO_3 solution to remove soluble salts (e.g., sodium and potassium). The Cs-loaded solvent is then stripped of the Cs by a dilute (0.001M) HNO_3 solution in the strip stage centrifugal contactors, generating a dilute acidic solution (strip effluent) that contains the concentrated Cs. The strip effluent is stored in the Strip Effluent Hold Tank (SEHT) (TK-205) before transfer to DWPF. The solvent is further treated by a caustic wash stage to remove impurities and is then returned to the Solvent Hold Tank (SHT) (TK-202) for reuse in the extraction stage.

The third process is the Alpha Finishing Process (AFP), which provides the option of performing an MST strike, mixing, and filtration on DSS exiting the CSSX process. The AFP provides operational flexibility that maximizes SWPF throughput and optimizes MST consumption. The AFP produces filtrate (DSS with further reduced actinide and Sr concentrations) that is sent to the Decontaminated Salt Solution Hold Tank (DSSHT) (TK-207) for transfer out of the facility. This process also produces concentrated MST/sludge slurry containing actinides and Sr, which is sent back to AST-A (TK-101) for reuse or sent via the SSRT (TK-104) to DWPF for further treatment.

Figure 2-7. Simplified Process Flow Diagram



If indicated by waste feed or process batch analysis, the DSS may be sent to the Intermediate Storage Tank (IST) (TK-220) in the AFF. From there, the DSS is sent to Alpha Sorption Tank-B (AST-B) (TK-221), where another MST strike and mixing are performed. The MST/sludge in AST-B (TK-221) is then transferred into Filter Feed Tank-B (FFT-B) (TK-222), where it is recirculated through CFFs to produce a concentrated MST/sludge slurry and filtrate, the latter being a DSS with further reduced actinide and Sr concentrations that is sent to the DSSHT (TK-207). The concentrated MST/sludge slurry is sent to the MST/Sludge Transfer Tank (TK-224) for temporary staging for subsequent transfer to SSRT (TK-104) where it is combined with the ASP MST/Sludge for transfer to DWPF.

P-DB-J-00003, *SWPF Process Basis of Design*[27]. provides more detailed descriptions of the three SWPF waste treatment processes.

2.3.2 Critical Process Equipment and High-value Property

There is no critical process equipment located within SWPF. Such equipment is essential to continued operation of a vital facility associated with national security interests (refer to Section 1.0). As documented in S-SAR-J-00002[4], there are no passive or active engineered controls required by the nuclear criticality safety analysis. As such, the SWPF contains equipment essential to operations and completion of its stated mission, but no equipment that requires special protective measures.

The impact on operations from a fire is expected to be minimal, and recovery would occur quickly. A fire is expected to be controlled by a few sprinklers with minor physical damage.

High-value property is generally considered equipment or individual items with a value in excess of $1 million. The items valued greater than $1 million are listed in Table 2-1. Several systems are over $1 million, but no individual components of those systems exceed that amount.

Table 2-1. Items Greater than $1 Million

Equipment No.	Equipment Name	Description
BC-101	Bridge Crane, Operating Deck	20-ton Bridge Crane
TK-101	AST-A	37,700 gallon Stainless Steel American Society of Mechanical Engineers (ASME) Pressure Vessel (Data Sheet M-DS-J-00037, *Alpha Sorption Tank-A [AST-A] TK-101*[28])
TK-102	FFT-A	37,700 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00038, *Filter Feed Tank-A [FFT-A] TK-102*[29])
TK-104	SSRT	6,300 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00040, *Sludge Solids Receipt Tank [SSRT] TK-104*[30])
TK-109	Salt Solution Feed Tank	45,000 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00045, *Salt Solution Feed Tank [SSFT] TK-109*[31])
TK-205	SEHT	19,900 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00054, *Strip Effluent Hold Tank [SEHT] TK-205*[32])
TK-207	DSSHT	43,600 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00056, *DSS Hold Tank [DSSHT] TK-207*[33])
TK-220	IST	37,700 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00063, *Intermediate Storage Tank [IST] TK-220*[34])
TK-221	AST-B	37,700 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00064, *Alpha Sorption Tank-B [AST-B] TK-221*[35])
TK-222	FFT-B	37,700 gallon Stainless Steel ASME Pressure Vessel (Data Sheet M-DS-J-00065, *Filter Feed Tank-B [FFT-B] TK-222*[36])
EXT-201 A thru I EXT-203 J thru P EXT-204 A thru B	Extraction Contactors Stripping Contactors Caustic Wash Contactors	West-side Contactor Modules
EXT-201 J thru P EXT-202 A thru B EXT-203 A thru I	Extraction Contactors Solvent Scrub Contactors Stripping Contactors	East-side Contactor Modules

2.3.3 Safety Class Equipment

As discussed and documented in S-SAR-J-00002[4], no SC SSCs have been identified for the SWPF. As such, no SSCs identified in this analysis are subject to comprehensive analysis and mitigation of consequences regarding fire-induced failures.

2.4 Facility Assumptions and Constraints

Cable in conduit is not considered by this analysis to be a combustible, and thus was not included in fire loading characterizations. Other combustibles are maintained in accordance with PP-EN-5043[6]. Nitric acid concentrations and temperatures are maintained well below that required to create a red oil explosion if it came into contact with a mixture of TBP transferred from the H-Tank Farm.

3.0 FIRE PROTECTION ANALYSIS

Because of the generic aspects of the Administration and support buildings associated with the SWPF, the emphasis of this analysis is on the SWPF Process Building. The Administration Building, Compressor Building, and the NGS Building do not require an analysis as extensive as does the Process Building. This FHA includes a brief life safety and fire protection analysis of these buildings and the exposure of these buildings to the Process Building.

3.1 Fire Area Definitions

The SWPF Process Building includes both heavily shielded unoccupied areas that support salt waste processing and storage and occupied areas for operations, maintenance, radiological control, and administrative activities. Confinement barriers and associated ventilation systems maintain continuous, cascading air flow to progressively more contaminated areas. This is discussed further in Section 3.2. The Process Building is separated into 16 distinct Fire Areas as follows:

1. Process Vessel Cell Area (R191, R192, R193, R194, R195, R196) and Waste Transfer Enclosure (WTE) (R190);
2. North ASP Pump and Valve Gallery (P&VG) (R131, R131A, R131B, R131C, R131D, R131E, R131F), South ASP and CSSX P&VG (R135, R135A, R135B, R135C, R136, R136A, R136B, R136C, R136D, R136E, R136F, R136G), Material Staging and Storage Area (R130, R132, R132A, R132B, R132C, R133, R133A), West CSSX Tank Cell (R138), Back-up Air Receiver Storage (R180), Safe Shut-down Panel Room (R181), and Waste Transfer Access Room (R290); all four stair shafts (1NW, 2NE, 3SE, and 4SW) and the Equipment Lift shaft (R500);
3. Control Room, Information Technology (IT) Server Room (R116, R116A, R116B, R117, R118, R118A);
4. North and East Facility Support Area (R100, R100A, R100B, R100C, R101, R102, R103, R104, R105, R106, R107, R108, R109, R109A, R109B, R109C, R110, R111, R111A, R111B, R111C, R112, R113, R114, R115, R120, R120A, R120B, R120C, R120D, R121, R122, R123, R124, R125, R126, R126A, R126B, R126C, R127, R127A, R128, R129, R129A, R182, R183);
5. Exhaust HEPA Filter and Fan Rooms (R202 and R203);
6. Contactor Support Floor and Contactor Operating Deck (R216 and R252);
7. Cell Inlet HEPA Filter Room #2 at 116-0 ft, Filter Storage and Drop Area at 116-0 ft, CSSX Tank Cell Operating Deck (R201, R201A, R211, R212, R212A, R213, R214, R250, R251);

8. Process Vessel Cell Operating Deck (R301, R301A, R310A, R310B, R310C, R310D, and R311);
9. HEPA Filter Rooms and Laboratory Hot Cell Exhaust Room at 139-0 ft (R302, R302A, R303, and R304);
10. CCA (R150, R150A, R150B, R150C, R150D, R150E, R151, R152, R153, R154, R154A, R155, R156, R157, and R158);
11. AFF (R140, R141, R142, R143, R143A, R144, and R145);
12. AFF HEPA Filter Room (R146);
13. Analytical Laboratory Area and Hot Cell (R300, R300A, R312, R312A, R312B, R312C, R312D, R313, R314, R315, R315A, R316, R317, R318, R319, R319A, and R320);
14. South Utility Chase, Contactor Support Floor Chase, and West Utility Chase (R215, R216A, and R253);
15. East CSSX Tank Cell (R138A); and
16. HVAC Shielding Chase (R204).

Arrangement of the Fire Areas within the Process Building discussed in this section is shown in Section 2.0 and in Figure 2-2a, Figure 2-4, Figure 2-5, and Figure 2-6.

3.2 Fire Area Description and Analysis

3.2.1 General

3.2.1.1 Fire-Rated Construction and Fire Barriers

IBC-2003[21], which is invoked by A-RPT-J-00001, *International Building Code and NFPA 101 Life Safety Code Review*[37], requires the structure to have a minimum one-hour fire-rated construction.

Table 302.3.2 of IBC-2003[21], requires occupancy separation of Group F-2 and Group H-4 Occupancies using one-hour barriers. Since radioactive material will be handled in this building, NFPA 801, *Fire Protection for Facilities Handling Radioactive Materials*[38], was considered. The Appendix to NFPA 801[38] recommends three-hour fire barriers, unless determined otherwise by the FHA. However, DOE-STD-1066-99[15] and the Implementation Guide (DOE G 420.1-3: *Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety*[39]) for DOE O 420.1B[1] state that fire areas should be separated by fire barriers having a minimum two-hour fire-rating. Based on the relatively low level of combustibles, the fire areas in this facility are separated by two-hour fire barriers to limit the spread of fire. These barriers meet the intent of IBC-2003[21], NFPA 801[38], DOE-STD-1066-99[15], and DOE O 420.1B[1]. The two-hour fire barriers separating fire areas in the CPA are concrete. The AFF is separated from CCA and East Facility Support Area by two-hour fire barriers using gypsum board barriers.

DOE facilities typically have well-controlled combustible limits in design features and during operations. A two-hour fire severity requires a combustible load of approximately 20 pounds per square foot (lb/ft^2), according to Table 12.5.1 in the *NFPA Fire Protection Handbook*[40]. Table 12.5.2 of the *NFPA Fire Protection Handbook*[40] indicates that typical Government office buildings have less than 10 lbs/ft^2. These types of buildings are characterized as having moderate amounts of wood, paper, plastics, and carpeting. The SWPF is expected to have a lower combustible load per square foot (ft^2) than an office. The SWPF is characterized as having concrete and steel construction. Combustible materials are enclosed in tanks, piping, and cabinets. Therefore, two-hour fire-barriers are adequate for this facility.

In addition to the requirement for fire barriers, NFPA 801[38] requires nuclear facilities to be constructed of non-combustible materials. The walls, floor, and ceiling of the CPA are constructed of reinforced concrete and structural steel. A fire rating of four hours can be given to a 6.6-inch thick carbonate aggregate concrete wall according to Table 720.1(2) of the IBC[21]. Walls and floors in the CPA are a minimum 12” up to 36”. These walls and floors were designed to provide protection for anticipated loads, fire resistance, gamma-radiation shielding protection, and resistance to natural phenomena events. The AFF is constructed of protected steel, concrete, and gypsum board, which is adequate for this facility. The architectural drawings identify the fire rating requirements.

Section 706.4 of IBC-2003[21] requires structural steel supporting fire barriers to be protected with the same fire rating as the fire barrier walls it supports. Therefore, all structural steel supporting fire barriers are protected in accordance with IBC-2003[21]. Areas where the structural steel is protected include the roof of the CPA, the AFF structural steel, the CCA structural steel, and FSA structural steel. Various methods of protection are being employed. Some areas have used spray-applied fire-resistant material or an intumescent fire-resistant material and some areas have used a rigid mineral wool board. Materials for column protection and beam protection are tested by Underwriters Laboratory (UL) and are given a UL Design number. These numbers are found on the Architectural design documents where required. The exposed steel in the ceiling of the process cells was placed for constructing the ceiling, but it is not required to support the structure, so this steel is not required to be protected. The roof level beams in FSA are not protected as allowed by the exception to Table 601 of IBC-2003[21] for roof construction over 20 ft above the floor for this F-2 occupancy.

Additional one-hour or two-hour fire-rated corridors and passageways are constructed of gypsum board. These barriers are discussed within the fire area sections where they are located.

Penetration seals are installed for all penetrations (ductwork, piping, tubing, conduit, cables) through all designated Fire Area boundary walls, floors, and ceilings. The penetration seals used at SWPF are UL-listed, Factory Mutual (FM)-approved, or listed by a Nationally Recognized Testing Laboratory, including Chlorinated Polyvinyl Chloride vent piping, and were installed by appropriately trained personnel. All penetration seals are encompassed by a tested configuration.

Duct and piping chases are located on the north, south, and west sides of the building. Some chases connect two or more levels. These areas are designated as separate fire areas, and they are separated

by two-hour rated fire barriers. All chases are unsprinklered and are discussed below in the various Fire Area sections.

3.2.1.2 Other Systems

The SWPF Electrical Distribution System consists of normal power at 13.8-kilovolt (kV), standby power (supplied by a local DG at 480 volts), and an uninterruptible power supply (UPS) with 30 minute battery back-up. Normal power for the SWPF site is provided by 13.8-kV power feed lines from the H-Area Electrical Distribution System. SWPF service transformers will step the voltage down to three-phase 480-volts alternating current (VAC) for utilization by SWPF loads. Standby Power will consist of a DG that will provide power to required 480-VAC loads, if the normal power supply is interrupted. The UPS will supply voltage-sensitive 120-VAC instrumentation and control loads and is powered from the battery-powered inverter.

Portable dry chemical fire extinguishers are located and installed throughout the facility, in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*[41]. Automatic sprinkler systems are installed throughout the facility, with the exception of the Process Cells (dark cells), WTE, West Utility Chase, HVAC Shielding Chase, South Utility Chase, Contactor Support Floor Chase, and the East CSSX Tank Cell. These areas are considered adequately protected through equivalent means. The lack of sprinklers in these areas is fully analyzed in Equivalencies approved by DOE. These equivalencies are discussed in the fire area sections where they are used. The installed sprinkler systems are designed in accordance with NFPA 13[26]. The design complies with NFPA 13[26], Ordinary Hazard Group 2 occupancies, and delivers a minimum 0.20 gallons per minute per square foot (gpm/ft^2) over the most hydraulically remote 1,500 ft^2 of area for any given system. All sprinkler systems are less than the NFPA 13[26] allowable 52,000-ft^2 area of coverage.

The building contains a manually activated and a partially automatic fire detection system. The main Fire Alarm Control Panel is located in the Control Room along with a graphic annunciator for ease of operation. Manual pull stations are provided at each exit and smoke detectors are located in areas that are discussed below. Notification of occupants is accomplished by horns and strobes provided throughout occupied areas of the facility, in accordance with the Public Mode rules in NFPA 72, *National Fire Alarm Code*[42], in normally occupied areas. Private Mode rules are used in the Control Room. The Commentary to this section and the Definitions section indicates that Private Mode Signaling is appropriate in the Control Room. The Control Room is occupied continuously, the main Fire Alarm Control Panel (FACP) is located in the Control Room, and personnel in the Control Room direct emergency response efforts. Additional information is found in F-SD-J-00001, *Fire Detection/ Protection System Description*[43].

No automatic fire alarm notification is provided in areas like the dark cells that will likely never be occupied. Other areas with limited occupancy are not equipped with notification appliances. These limited access areas are treated as confined spaces, since there is no lighting or ventilation in these rooms. These areas will be entered only after preparation of a Job Hazard Analysis to identify hazards in the room, minimize time in the room, minimize hazards brought into the room, minimize hazardous steps during the task, and mitigate any potential hazards with corresponding controls, including having a confined space attendant. The main fire alarm panel, located in the

Control Room, is an addressable panel. A remote annunciator is installed in the Safe Shutdown Panel Room (R181) in the event that access to the Control Room is prevented. The fire alarm panel reports to the SRS Operations Center (SRSOC) via a digital alarm communicator transmitter, as required by F-SPP-G-00003, *Savannah River Site Fire Alarm Specification*[44].

Standpipe hose connections are provided in all stairwells and at other appropriate locations throughout the facility. Class I hose connections are provided in accordance with NFPA 14, *Standard for the Installation of Standpipes and Hose Systems*[45]. The system is designed with cross-connects and loops to minimize single-point failure effects on the combined sprinkler-standpipe system. The standpipes are also cross-connected in the east-west direction at the 139-0-ft elevation to enhance flow and maintainability of the system. Isolation valves are provided at each standpipe to provide redundant water supply if sections of the system are out of service.

As mentioned above, the facility is not provided with sprinklers in the dark cells and chases since these areas are not normally occupied, they are contained in separate fire areas, and they contain no ignition sources and little to no combustibles. The Process Cells are referred to as dark cells that are not intended to be occupied after initiation of hot operations. As such, there is no other protection (standpipes or portable extinguishers) or occupant notification (horns and strobes) in these areas.

3.2.2 NFPA 801 Requirements

3.2.2.1 General

SWPF is a non-reactor nuclear facility and is required to comply with NFPA 801[38]. This standard is based on the concept of defense-in-depth (DID), which is achieved when a balance of each of the following elements is provided:

1. Preventing fires from starting;
2. Detecting fires rapidly, and controlling and extinguishing promptly those fires that do occur, thereby limiting damage and consequences; and
3. Providing a level of fire protection for SSCs so that a fire that is not promptly extinguished will not prevent essential facility functions being performed.

NFPA 801[38] requires implementation of the basic elements of a structured Fire Protection Program. Significant elements are management policy and direction, a documented FHA, a documented fire prevention program, testing and maintenance, impairment control procedures, a written emergency response plan, a fire emergency team organization, and detailed fire pre-plans.

The CPA of the facility is constructed of reinforced concrete, which is sub-divided into Fire Areas. The Process Cells are located within the CPA and are segregated into compartments. The Process Cells are sealed and are inaccessible during normal operations. These areas have minimal combustibles and the remaining areas outside the cells are fully sprinklered, except for the areas under the Equivalencies previously mentioned.

Surface finishes in these areas will meet the requirements of NFPA 101[24] and NFPA 801[38] for flame spread rating and for ease of cleaning where appropriate. All surfaces that have the potential to be contaminated and require routine access are coated appropriately. For example, the walls, ceiling and floor in the labyrinth areas are coated with an epoxy finish. These areas can also be washed using the Flush Water System installed in each labyrinth room. To aid in cleaning, varying concentrations of nitric acid can be added to the Flush Water System. The dark cell surfaces are bare concrete since these areas will not be entered after operations begin.

A general requirement of NFPA 801[38] is that sprinkler systems be installed in accordance with NFPA 13[26]. Sprinkler systems are discussed in later sections. SWPF meets the intent of other requirements of NFPA 801[38] as shown in the following sections.

3.2.2.2 Water Run-off Drainage and Containment

Section 5.10 of NFPA 801[38] requires contamination control, including containment or drainage of sprinkler water discharge. The goal of the water containment is to prevent potentially contaminated water reaching the outside. Water discharged is collected only from areas of radiological concern in accordance with NFPA 801[38]. The requirement for drainage includes any flammable and combustible liquids, a credible volume of sprinkler discharge, hose stream flow from manual fire-fighting, contents of containers and piping subject to failure, and natural sources if the area is outside. In this facility, tanks are located in cells or diked areas that would accommodate the volume of a tank failure. The design of the water containment system in SWPF was based on the activation of the three *least* remote sprinklers. Sprinkler system discharge was estimated at 55 gallons per minute (gpm) for the three least remote sprinklers (or 165 gpm) for 30 minutes for a total of 4,950 gallons. A nominal quantity of 500 gallons for fire knock-down by the fire department was added to the design volume for a total of 5,450 gallons.

The deluge systems in three of the North Labyrinth rooms contain six open sprinklers. Drainage from a discharge of these systems occurs through the labyrinth sumps and corridor floor drains. The labyrinths and CSSX Tank Cells drain either to Alpha Sorption Drain Tank (TK-601) or Solvent Drain Tank (TK-208) in the Alpha Sorption Drain Tank Cell. Floor drains in the P&VG corridors, stairwells, and other CPA areas drain to Low Level Drain Tank (TK-604) in the AFF containment sump. The analytical laboratory gloveboxes and the hot cell drain to Lab Drain Tank (TK-235). The general scheme of the sprinkler discharge drainage system is to allow liquids to flow from upper floors to the bottom floor and then collect in drains located on the bottom floor. Drains are located in the Stairwells #1 and #4 and a trench drain was added in front of the door in the Waste Transfer Access Room so that potentially contaminated water does not flow past the perimeter of the building. Sprinkler discharge from non-contaminated areas would flow out of the building, into sanitary drains, or into the contaminated areas. The sanitary drains are a separate system from the process building floor drains.

The six sprinkler discharge in the North Labyrinth is the second largest discharge. The process drain calculation, M-CLC-J-00096, *Process Drain Line Sizing Calculation*[46], concluded that the drain systems for the deluge systems were adequate to drain more than the anticipated sprinkler discharge.

Discharge in the Contactor Operating Deck and Contactor Support Floor could potentially be the three sprinklers at the Operating Deck (as anticipated above) plus 20 deluge sprinklers (with both the East and West systems flowing) at the Support Floor below. The Contactor Support Floor is a large enclosure with one opening, a 3-inch drain that leads to the East CSSX Tank Cell sump (SMP-217). The East CSSX Tank Cell sump is designed with a 6-inch overflow pipe that directs any excess liquid to the Solvent Drain Tank (TK-208) in the Alpha Sorption Drain Tank Cell.

The drains in the laboratory hoods and gloveboxes are sized for a single sprinkler operating. The hood and glovebox sprinkler systems are provided with pressure reducing stations to drop the water supply pressure from approximately 140 Pounds per square inch (psi) to 30 psi. The sprinklers in the hoods and gloveboxes are low flow, K factor of 1.4 and 2.8, respectively, so the flow is much lower than from a standard sprinkler. Drains in the hot cell and gloveboxes drain to Lab Drain Tank (TK-235), in the ASDT Process Cell. Drains in the hoods drain to the Lab Collection Tank (TK-236) in AFF.

3.2.2.3 Requirement for Active Ventilation Confinement

To address the Defense Nuclear Facilities Safety Board technical positions regarding adequate confinement strategies, DOE has adopted a policy to provide safety-related active ventilation systems for the SWPF to protect workers from process upsets involving a significant release of radioactive material due to non-NPH events (SPD-SWPF-0179, *Design Approach for Providing Performance Category 3 [PC-3] Confinement for the Salt Waste Processing Facility*[47]). DOE provided specific contractual direction to include safety-related active ventilation systems for the SWPF in accordance with this policy in Contract Modification M026, DE-AC09-02SR22210, *Design, Construction and Commissioning of a Salt Waste Processing Facility (SWPF)*[48]. Therefore, the SWPF active ventilation systems are required to continuously operate in accordance with DOE policy and contract direction and are not designed to be shut down.

Sections 9.5.2 and 14.4.2.3 of DOE-STD-1066-99[15] acknowledge that fire dampers should not be used where ducting is part of a ventilation system that is required to continuously function and NFPA 801[38] permits the omission of fire dampers in ventilation systems required to operate for confinement purposes. In accordance with these standards, fire dampers are not installed in the SWPF active confinement ventilation system ducting where their operation would be detrimental to the system's ability to continuously function. Alternate means of fire barrier protection are provided where fire dampers are omitted in accordance with Section 14.4.2.3 of DOE-STD-1066-99[15]. Specifically, an engineering analysis demonstrating duct integrity over a two-hour fire exposure in accordance with Appendix D of DOE-STD-1066-99[15] has been performed and is documented in calculation C-CLC-J-00010, *HVAC Duct Analysis at Firewall Penetrations*[49].

3.2.2.4 Fire Barrier Protection of Duct Penetrations

Normally, fire dampers are installed in ductwork where the duct passes through a fire barrier, as required by NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*[50]. Section 5.9.1.2 of NFPA 801[38], exempts radiological ventilation systems that are required to operate from this requirement, provided that alternate protection is provided for the

ductwork. Section 14.4.3.2 of DOE-STD-1066-99[15] states that dampers should not be used where ductwork is an integral part of the nuclear air filter system that is required to function continuously.

The Standard recommends two types of alternative duct penetration protection that may be used for those ventilation systems that are required to continuously function. As an alternative to fire dampers in the ductwork, the penetrating ductwork can either 1) be wrapped with fire wrap, or 2) the ductwork can be analyzed to show that the duct will remain intact for the duration of the fire. For the SWPF design, fire dampers are not installed on ducted confinement ventilation paths where they pass through a fire barrier. Ducted confinement ventilation paths have been defined as hard-ducted (not transfer air) from a Zone 2 room (i.e., the North ASP P&VG) to the Cell Inlet HEPA Filter (FLT-011 or FLT-013) to Zone 1 (SEHT Cell or AST-A Cell) and out to the stack. Non-ducted paths from Zone 2 (i.e., Process Vessel Ventilation System [PVVS]/ Pulse Mixer Ventilation System [PMVS] and Lab Vent Room) that have transfer air to the Cell Inlet Air HEPA Filter Room #1, where the Inlet HEPA filter takes suction from the room, and then the air is moved through an Inlet HEPA Filter to a Zone 1 Cell and then outside to the stack.

Ductwork penetrating the 2-hr rated fire barrier walls, including the dark cell walls, has been analyzed to show that fire wrap is not required, as permitted by NFPA 801[38] and DOE-STD-1066-99[15]. This condition is analyzed in calculation C-CLC-J-00010[49]. Although fire wrap was used in some places, it is not required to be inspected or maintained as a credited feature as this only provides additional conservative protection.

3.2.2.5 Smoke Control

The Process Building Ventilation System cascades 100 percent (%) outside air from less potentially contaminated areas to more potentially contaminated areas, and finally to HEPA filters before reaching the stack. The more potentially contaminated areas are less occupied areas, and the dark cells are not occupied. Smoke would be controlled in the same way. Making use of the cascade ventilation system, smoke from a fire will flow from occupied areas to less occupied areas (higher pressure areas to lower pressure areas), to the dark cells, and then to HEPA filters before reaching the stack. The stairs are not ventilated so the pressure inside the stairs is higher than all areas of the CPA. This meets the requirement of Section 5.9.5 of NFPA 801[38], for smoke control.

An exception to this is the Control Room ventilation system, which is designed for 100% recirculation in case of an accident. This system is designed to prevent potentially contaminated air entering the Control Room. The Control Room ventilation system maintains the Control Room at a slight positive pressure, with respect to the atmosphere (the rest of the facility is maintained at a slight negative pressure with respect to the atmosphere). This positive pressure will prevent smoke entering the Control Room. The Control Room HVAC System was modified to allow remotely controlled switchover to 100% recirculation by adding air-operated actuators to the chilled water valves. These valves can now be operated from the control room. The determination of when to use this option will be on a case by case basis as determined by personnel in the Control Room.

The AFF Ventilation System supplies 100% outside air to the AFF space and the AFF Exhaust System exhausts the air through the exhaust HEPA filter and to the stack. The AFF ventilation system maintains the room at a negative pressure with respect to atmosphere. This system also meets the requirement of Section 5.9.5 of NFPA 801[38], for smoke control. Although the CCA is not required to meet NFPA 801[38], this area is also supplied with a 100% outside air with 100% of the air exhausted through roof-mounted fans.

3.2.2.6 Fire Protection of Active Ventilation Confinement/Application of DOE-STD-1066-99

DOE-STD-1066-99[15] recommends fire protection for final exhaust HEPA filters larger than 16 ft^2 in surface area for nuclear air cleaning ventilation systems, and the guidelines can be used for other filtration and cleaning systems as well. DOE-STD-1066-99[15] recommends an automatic deluge system upstream of the prefilters (or demisters) and a manual water spray system upstream of the first stage of the HEPA filters. The Fire Protection System may be an automatic deluge system activated by a heat detector in the duct upstream, or the system may consist of a heat detector that notifies personnel to open a manual valve to a water spray system. Rate-of-rise detection is the preferred means of heat detection in the Standard; however, pilot sprinklers connected to a pneumatic deluge release valve are also permitted.

Appendix C of DOE-STD-1066-99[15] states “The term ‘deluge spray system’ is used throughout this standard to provide flexibility for the cognizant Fire Protection Engineer to select the appropriate system.”

This FHA demonstrates that a fire in a HEPA filter is unlikely, and that the protection provided is adequate for the anticipated hazards. In the SWPF, 14 HEPA filters are larger than 16 ft^2. These are listed in Table 3-1.

Table 3-1. HEPA Filters larger than 16 ft^2

Filter #	Surface Area	Description
FLT-001	48 ft^2	Dark Cell Exhaust Filter
FLT-002	48 ft^2	Dark Cell Exhaust Filter
FLT-003	48 ft^2	Dark Cell Exhaust Filter
FLT-004	48 ft^2	Dark Cell Exhaust Filter
FLT-007	96 ft^2	AFF Exhaust Filter
FLT-009	36 ft^2	Laboratory Exhaust Filter
FLT-010	36 ft^2	Dark Cell Inlet Filter
FLT-011	24 ft^2	Dark Cell Inlet Filter
FLT-012	36 ft^2	Dark Cell Inlet Filter
FLT-013	36 ft^2	Dark Cell Inlet Filter
FLT-014	48 ft^2	Dark Cell Inlet Filter
FLT-015	36 ft^2	CSSX Cell Inlet Filter
FLT-016	48 ft^2	Dark Cell Inlet Filter
FLT-017	36 ft^2	Laboratory Exhaust Filter

Of these 14 filters, seven are final exhaust HEPA filters. Filters FLT-10 through FLT-16 are not final exhaust filters. See SWPF-10-217, *Contract No. DE-AC09-02SR22210, Salt Waste Processing Facility Project Parsons Letter, Breor to Polk, 00-700-15706, 6/22/10, Request for Standard 1066 Equivalency Approval*[51], for the DOE acceptance of this approach to fire protection of the HEPA filters in SWPF. This was assigned an equivalency tracking number of F-ESR-J-00003, Rev. 0, in DOE Approval Letter SWPF-10-217[51].

3.2.2.6.1 Laboratory and Hot Cell HEPA Filters

The laboratory final exhaust HEPA filters (FLT-009 and -017) are provided with a water scrubber upstream of the HEPA filters. The purpose of the water scrubbers is to remove corrosive fumes from the air stream. However, the scrubbers will also work to protect the HEPA filters from high temperatures entering the filter housing when the airstream passes through the water spray. The exhaust air flows through a continuous curtain of water before reaching the HEPA filters. The Hot Cell HEPA filters (FLT-021 and -022) are similarly protected, even though these filters are not larger than 16 ft^2. HEPA filters are not designed to be wetted continuously or periodically. The scrubbers upstream of these filters add water vapor to the air. The scrubbers are equipped with mist eliminators to remove the water vapor from the air. In addition, pre-filters in the HEPA filter housings will stop air-borne water droplets from reaching the HEPA filters. Since each Laboratory and Hot Cell exhaust filter is adequately protected by an upstream scrubber, these filters will not have additional fire protection.

3.2.2.6.2 Process Building Ventilation System and AFF HEPA Filters

Table 3-2 presents the five final exhaust HEPA filters greater than 16 ft^2 that are protected by a Fire Protection System.

Table 3-2. HEPA Filters Protected by a Fire Protection System

Filter #	Surface Area	Description
FLT-001	48 ft^2	Dark Cell Exhaust Filter
FLT-002	48 ft^2	Dark Cell Exhaust Filter
FLT-003	48 ft^2	Dark Cell Exhaust Filter
FLT-004	48 ft^2	Dark Cell Exhaust Filter
FLT-007	96 ft^2	AFF Exhaust Filter

As recommended by DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook*[52], the SWPF exhaust filters consist of a prefilter and two stages of HEPA filtration in series. Instrumentation monitors differential pressure across each of the filter elements. If a HEPA filter fails in the Process Building Ventilation System (PBVS), it can be isolated and exhaust flow maintained through parallel filters, if available. If no functioning spare HEPA filters are available, the building ventilation system would be shut down and protective actions taken for facility workers. In the case of the AFF ventilation system, the system would be shut down and protective actions taken for facility workers.

Two fire scenarios are typically analyzed for radiological ventilation systems: 1) a fire external to the system, and 2) overheating of the filter from heat developed internally. In the first fire scenario, a fire external to the filters in the HEPA Filter Room would be controlled by the automatic sprinklers in the room before the HEPA filters overheat.

A fire internal to the system is the result of a fire entering the HEPA filters through the ductwork. A fire developing in the HEPA filters must have a sufficient ignition source and a fuel.

There are two issues of concern with air filters. As the filters clean the air, they collect potentially combustible particles, primarily dust. This issue is partially alleviated for the final HEPA filters since the air is routed through the cell inlet HEPA filters before the air enters the dark cells and then to the final HEPA filters. Also, as the filters clean the air, the filter media becomes plugged. If a fire occurred in the ductwork or in the HEPA filters, the filters could fail due to a blow-out from either melting of the filter (without fire suppression), water impingement on the filter (with deluge fire suppression), or smoke plugging of the filter (with or without fire suppression).

The SWPF does not include processes that produce build-up of combustible metals, such as plutonium, so there would be no build-up of combustible metal inside the ductwork or on the filters. The primary combustible material used at SWPF is the CSSX solvent that contains Isopar L, a Class IIIA combustible liquid that is difficult to ignite. The postulated fire in the dark cells would not produce burning embers.

All HEPA filters for this facility meet the requirements of ASME AG-1-1997, *Code on Nuclear Air and Gas Treatment*[53]. The pre-filters in the HEPA enclosures meet UL 900-2012, Seventh Edition, *Standard for Air Filter Units*[54]. These HEPA filters are defined as "those that, when clean, burn moderately when attacked by flame or emit moderate amounts of smoke or both". The 1st and 2nd stage HEPA filters in the HEPA enclosures meet the requirements of UL 586-2009, Ninth Edition, *Standard for High-Efficiency, Particulate, Air filter Units*[55]. These HEPA filters must pass the spot flame test, which is defined as "the downstream face of the filter shall not continue to flame more than 2 seconds after removal of the test flame." Section 5.9.3.1 of NFPA 801[38] requires compliance with an old version of UL 900 that no longer exists. However, the requirements of UL 586-2009[55] meet the intent of the NFPA 801[38] requirement. The glass fiber filter medium does not burn freely, but melts when exposed to flame. Maximum operating temperatures for HEPA filters are typically 140-160 degrees (Fahrenheit [°F]), though high-temperature filters are available for up to 750°F operation. The UL test includes a dry air test at approximately 700°F and a spot flame test with a Bunsen burner at approximately 1,750°F. This assures that if a burning ember were found in the HEPA filter, the ember would begin to melt the glass filter medium, potentially ignite any residual dust, then self-extinguish.

A fire scenario was developed in Equivalency F-ESR-J-00002, *SWPF Fire Protection Engineering Equivalency Request Process Building Omission of Sprinklers in Process Vessel Cell Area*[56], which showed that a fire in a Process Cell will cause a negligible temperature rise at the final exhaust HEPA filters (FLT-001, -002, -003, and -004), due to the mixing and dilution with cooler air from other cells. If a significant fire occurred in one of the cells, the Equivalency determined that smoke would flow to the filters, but the filters would not experience temperatures that would degrade the filters. The exhaust duct temperature from each Process Cell is monitored by the basic process control system and a high temperature interlock will close the supply air off to that cell if the temperature exceeds its setpoint. This will essentially starve the fire of oxygen.

For HEPA filters, the preferred method of fire protection is to use adequate dilution of the air stream and adequate face area of the filters to preclude plugging (see *Fire Protection Considerations in the Design of Plutonium Handling and Storage Facility HVAC Systems*[57]). The design and operation of support and protection systems, such as fire protection, should not promote the failure of the enclosure system integrity or the loss of confinement (see page I-12 of DOE-HDBK-1132-99, *Design Considerations*[58]).

3.2.2.6.3 AFF Ventilation System Final Exhaust HEPA Filters - Internal Fire

The AFF final exhaust HEPA filter (FLT-007) filters air from a single area. The volume of AFF is relatively large (47 ft x 163 ft x 40 ft, or 306,440 cubic ft) and the flow rate of air filtered through the exhaust system is relatively large (29,370 cubic ft per minute [cfm]). Potential fuel and ignition sources, such as motors, are not concentrated in the space. In addition, motors are located on concrete pads over 5 ft high. Smoke from a fire would likely be diluted. The exhaust duct intakes are located at opposite ends of the room. The west exhaust duct collects air five (5) ft above the floor, and the east exhaust duct collects air 13 ft above the floor in the approximately 40-ft high room. The exhaust system would continue to draw cooler, diluted air from the bottom of the room as the smoke layer from a fire descended into the room. Since the air supply is near the roof, there

is a cross-flow from the top of the room to the bottom that would mix and dilute smoke before it enters the exhaust system.

A small fire from transient combustibles that spreads to fixed combustibles, such as cable trays, would be controlled by the sprinkler system. Another fire scenario is that of a fire originating at a motor and spreading to transient combustibles beside the motor. This type of fire would also be controlled by the sprinkler system. As previously discussed, a large fire in the AFF is unlikely based on the following:

1. The AFF is protected by automatic sprinklers.
2. The Class IIIA solvent and the potential build-up of solvent vapors are contained by stainless steel piping and vessels.
3. The Class IIIA solvent inside the piping and vessels is further controlled by mechanical systems that maintain the vapor concentrations below 25% of Composite Lower Flammability Limit (CLFL).
4. A spill of solvent would have to be heated to its flash point for ignition to occur.

The following sequence of events would occur should a fire develop in the AFF:

1. The automatic sprinklers would control the fire.
2. Smoke from the fire would be diluted before entering the exhaust system.
3. All air exhausted from the AFF will pass through an ember screen to knock down any embers that may pass through the duct.
4. The air must travel a long path with several turns before entering the HEPA filter housings, further limiting the possibility that embers could reach the prefilters in the HEPA filter housings.
5. Finally, if fire reaches a HEPA filter, the rate-of-rise heat detector will actuate an alarm at the main Fire Alarm Control Panel. Stopping flow through the HEPA filter and actuation of the manual fire suppression would be performed in accordance with approved emergency response procedures.

This water spray system is designed for 1 gpm per 500 cfm air flow as recommended in DOE-STD-1066-99[15], which is greater than the alternate requirement of 0.25 gpm/ft^2 of surface area of the HEPA filter. This level of protection is considered adequate for this configuration.

3.2.2.6.4 Process Building Ventilation System Final Exhaust HEPA Filters - Internal Fire

The PBVS final exhaust HEPA filters (FLT-001, FLT-002, FLT-003, and FLT-004) filter air from multiple Zone 1 areas. The volume of these areas is large and the room pressures are around -3.0 inches water gauge. The air flow rate from the rooms through each HEPA filter is approximately 14,210 cfm. The scenario for an internal fire in the PBVS is that of a fire in another room that sends high temperature air through the ductwork and into the filter housing. The calculation, F-CLC-J-00011, *Air Temperature Change at HEPA Filters Resulting from Fire in a Process Cell*[59],

was prepared to analyze a fire in each process cell using 500 gallons of CSSX solvent. The calculation concluded that a fire in any one of the cells would not cause the combined air temperature at the HEPA filters to exceed 200°F. As previously discussed, a fire in a cell is unlikely based on the following:

1. There are no transient combustibles in the Dark Cell Fire Area.
2. There are no exposed fixed combustibles in the Fire Area.
3. The Class IIIA solvent and the potential build-up of solvent vapors in the piping and vessels are contained by use of stainless steel piping and vessels, which are also credited in S-SAR-J-00002[4] for confinement of the waste.
4. The Class IIIA solvent inside the stainless steel piping and vessels is further controlled by mechanical systems that maintain the vapor concentrations below 25% of CLFL.
5. If there was a spill of solvent into one of the cells, either by failure of the piping and vessels and mechanical systems or by overflow of a tank through an operations failure, there is not sufficient energy in the limited and contained ignition sources to heat the solvent to its flash point or to sustain a solvent fire.
6. If a Class IIIA solvent fire was sustained, there are insufficient quantities of solvent to cause a breach in the fire barriers that contain this Fire Area or reduce the level of life safety in the building (see F-CLC-J-00011[59]).
7. If a Class IIIA solvent fire was sustained, a solvent fire is not likely to emit burning embers into the fire plume and into the ductwork.

The following sequence of events would occur should a fire be sustained in a dark cell:

1. A temperature rise in the exhaust from a dark cell will be detected by the Distributed Control System (DCS), and the DCS will automatically close the inlet supply air to the cell.
2. The exhaust system will continue to operate, creating a higher negative pressure in the cell to maintain the cascade ventilation system and starve the fire of oxygen.
3. Air from this cell will be mixed with air from other cells to cool and dilute the air from this cell.
4. In addition to the dilution air, all air exhausted from the cells will pass through an ember screen to knock down any embers that may pass through the duct.
5. The air must travel a tortuous path from the dark cells to the HEPA filter housings, further limiting the possibility that embers could reach the prefilters in the HEPA filter housings.
6. Finally, if fire reaches a HEPA filter, the rate-of-rise heat detector will actuate an alarm at the main Fire Alarm Control Panel and at a remote annunciator in the fan room adjacent to the HEPA filter room. Stopping flow through the HEPA filter and actuation of the manual fire suppression will be performed in accordance with approved emergency response procedures.

This water spray system is designed for 1 gpm per 500 cfm air flow as recommended in DOE-STD-1066-99[15], which is greater than the alternate requirement of 0.25 gpm/ft^2 of surface area of

the HEPA filter. This level of protection is considered adequate for this configuration. Although this level of protection is considered adequate for this configuration, the system has not been hydraulically calculated as of this revision. This is an Open Item. Emergency response procedures are identified in EOP-SWPF-001, *Fire/Explosion in 221-J*[6].

3.2.2.7 Hot Cells and Gloveboxes

Also unique to this building are the Hot Cells and gloveboxes. Sections 7.4.3.1 and 7.4.4.1 of NFPA 801[38] require Hot Cells and gloveboxes to be made of noncombustible construction. The Hot Cell is made of concrete, steel, and glass. The Hot Cell glass windows are lead-shielded. The gloveboxes are made of steel and glass. The windows contain an inner layer of polyvinyl butyral, which is a high-density plastic used for laminating glass. The glass is heat-formed at temperatures up to 1,100°F. Gasket and O-ring materials are specified as neoprene with Durometer 40-70 (hardness rating). Data sheets indicate that this material has a high operating temperature rating up to 220°F. The gloves are made of butyl, Hypalon, or lead-loaded neoprene materials. Hypalon has heat resistance properties up to 302°F. If the gloves melt, containment of the glove box would be breached. Consequently, gloves are tied outside the glove box or the glove ports are covered when not in use in accordance with Sections 7.4.4.3 and 7.4.4.4 of NFPA 801[38] (See Specification 14516, *Gloveboxes*[60]).

Section 7.4.3.4 of NFPA 801[38], states: “Where combustibles are present, a fixed extinguishing system shall be installed in the cell or cave”. Though the fixed extinguishing system is not required to be an automatic suppression system in the Hot Cell, automatic sprinklers are installed in the Hot Cell, which will provide detection and suppression.

Section 7.4.2 of NFPA 801[38], states: “Fire suppression shall be provided in all cells, caves, glove boxes, and hoods that contain combustible metals or organic liquids in quantities that have the potential to cause a breach of the hot cells, glove boxes, hoods, or caves”. This implies a suppression system may not be needed if the expected quantities of combustibles can be shown to not cause a fire large enough to breach the glove box. Section 7.4.4.7 of NFPA 801[38], appears to conflict with Section 7.4.2 of NFPA 801[38] stating for gloveboxes and hoods: “Where combustibles are present, a fire suppression system or fixed inerting system shall be provided”. This statement requires a suppression system regardless of the quantities of combustibles present. The conservative recommendation is to install a fire suppression system in the gloveboxes. Each glovebox and fume hood is equipped with a sprinkler. These systems are designed to provide 0.20 gpm/ft^2 of horizontal surface area inside the gloveboxes and fume hoods. The gloveboxes and hoods are provided with drains to route potentially contaminated water to a holding tank. The sprinklers provide a low flow (low K factor of 1.4 in the hoods and 2.8 in the gloveboxes) to reduce the sprinkler discharge to a flow rate that can be handled by the drain system.

Section 7.4.1 of NFPA 801[38], states: “All cells, caves, glove boxes, and hoods shall be provided with a means of fire detection if used in the handling of pyrophoric materials, oxidizers, or organic liquids”. As previously stated, the Hot Cell will have an automatic sprinkler system that will detect as well as control a fire. The gloveboxes and hoods will contain small quantities of flammable or combustible liquids and oxidizers in stainless steel containers, and small quantities of radioactive

material being analyzed. For conservatism, a suppression system was installed in the gloveboxes that also provides alarm notification. The hot cell is provided with a drain system to route potentially contaminated water to a holding tank.

3.2.3 Fire Area 1 – Process Vessel Cell Area and Waste Transfer Enclosure

This Fire Area contains the six Process Vessel Cells, which are located at the 88'-6"- and 100-ft elevations. The interconnecting piping, isolation valves, and SWPF process transfer pumps are located in the P&VGs at the 100-ft elevation, adjacent to the north and south walls of the Process Vessel Cells.

This area has four Process Vessel Cells containing waste processing vessels and piping used in the ASP, and two Process Vessel Cells containing vessels and piping for waste processing the CSS and strip effluent solution. Ports are provided in each cell to insert closed-circuit television (CCTV) cameras, if required. Sump level detectors are also provided to remotely monitor cell internal conditions.

The WTE is also included in this Fire Area. The WTE has a stainless steel liner and is partially below grade to allow waste transfer lines to enter/exit the external wall of the WTE at least four feet below grade. The WTE is provided with a sump and a leak detector and equipped with a shield cover that can be removed via the access room located directly over the WTE at the 108-ft elevation. The WTE is accessible only by removing the concrete plug in the ceiling of the room, which is the floor of the Waste Transfer Access Room. The waste piping passes through the WTE before it enters the Process Cells. Remotely-operated shut-off valves are located in the WTE. The valve operators are located in the Waste Transfer Access Room above.

All processes in the Process Vessel Cells are remotely controlled. Because these cells do not contain any process equipment that requires hands-on operation, maintenance, or inspection, the cells do not require or permit access during operation. Pumps are located outside the cells in the adjacent P&VGs. Valves are located inside the cells and are remotely maintainable.

Each Process Vessel Cell is constructed of reinforced concrete walls on a concrete slab designed for anticipated loads, two-hour fire resistance, gamma-radiation shielding protection, and resistance to natural phenomena events. The Process Cell walls and the Operating Deck floor above are two-hour fire barriers. Removable shield plugs in the Operating Deck are provided for non-routine access to the Process Vessel Cells (e.g., insertion of robotic surveillance devices or a necessary personnel entry). The cells and vessels are equipped with spray nozzles that can be used to decontaminate the cell walls or vessel internals. The Process Vessel Cells are equipped with sump level detectors that provide an interlock function to stop liquid additions from key sources associated with the cell. All lines enter the Process Vessel Cells through shielded, direct-embedment fire-rated penetrations. Penetration seals meet radiological performance criteria in addition to fire ratings. These sump areas are identified as NFPA 70, *National Electrical Code*[61], for Class I, Division 1, hazardous locations. Although Isopar L in the solvent is a Class IIIA combustible liquid and only presents a concern when heated above its flash point of 144°F there is a remote possibility of a hydrogen (H_2) leak from the PVVS into the area. The requirements in

Section 6.3.1 of NFPA 69, *Standard on Explosion Prevention Systems*[62], are discussed later in this analysis and are based upon the HVAC, PVVS, and Air Dilution System (ADS).

External tank cooling is provided to cool the contents of the AST-A (TK-101), FFT-A (TK-102), SSRT (TK-104), Salt Solution Feed Tank (SSFT) (TK-109), and SEHT. Chilled water for the cooling jackets is provided from a primary/secondary closed-loop Chilled Water System. The jackets maintain the process fluids at temperatures that promote maximum process efficiency (e.g., Cs extraction into the solvent) and minimize evaporative losses from the processes. Estimates of radiolytic heating in the Process Vessels indicate that, under forced flow conditions, convection and radiant heat losses exceed the radiolytic heat generation rate.

Supply and exhaust ventilation ducts serve the Process Vessel Cells, penetrating the cell walls near the ceiling for the supply air ducts and halfway up the wall for the exhaust air ducts. As stated in Section 3.2.2.4, this ductwork has been analyzed to show that fire wrap is not required. Although fire wrap was used in some places, it is not required to be inspected or maintained as a credited feature as this only provides additional conservative protection. No fire wrap was used on ductwork inside the cells or in the HVAC shielding chase on the north side of the dark cells. To prevent build-up of flammable gases (e.g., radiolytic H_2 or solvent vapors) in all but one vessel (see Solvent Drain Tank [TK-208] description below), the PVVS draws air into the orificed vessel-top vent, through the vessel vapor space, and out through the PVVS exhaust system. The PVVS exhaust system is an active ventilation system required to operate to maintain the vessels below 25% CLFL so that a potential leak is not flammable and includes redundant HEPA filters and exhaust fans. The exhaust fans are provided with back-up power from the Standby DG to maintain an air purge of the vessel in the event of loss of normal power. If there is a leak of H_2 (or other combustible gases) from the vessels, the PBVS will prevent a build-up of H_2 in the room.

Process Vessel level, specific gravity indications, and some level and interlock functions are provided by differential pressure instruments driven by pneumatic dip tubes (bubblers) that use Plant Air (PA). For short-term interruptions of the PA supply, the PA System receiver will continue to feed the dip tubes.

The Plant Air System has sufficient redundant active components to ensure that dip tubes are supplied with PA in most abnormal conditions, with the exception of an event that results in a loss of normal and offsite power. For these events, the fail-safe design of the SWPF processes ensures that waste transfers and chemical additions will be stopped and isolated to stabilize Process Vessel levels without the need for immediate level monitoring. For a potential long-term PA interruption, appropriate connection points, regulators, flow-indicating controllers, and valves in the PA piping to the dip tubes allow operators to manually connect an engine-powered, portable air compressor to supply the dip tubes and re-establish level monitoring. The reference dip tube in the Process Vessel vapor space allows operators to manually draw a gas sample from the vessel vapor space to determine the concentrations of H_2 and other combustible gases.

The air pulse agitator (APA) agitates the vessel contents, using air as a motive force, but does not directly introduce air into the vessel during normal operation.

Compressed air to the APA is isolated before vessel liquid levels decrease to a point at which bubbling of air through the waste or impingement of air on the waste surface may initiate a release of radioactive material into the PVVS or out through the vent into the cell.

At low process vessel levels, the APAs are operated in the lift and drop mode. In this mode, instead of compressed air being used to force the liquid out of the pulse pot, the pulse pots are sequentially vented to the vessel head space and gravity is the sole motive force pushing the liquid column from the pulse pot into the vessel. PMVS is still relied upon to refill the pulse pots.

The primary fire hazards associated with the Process Cell area are the accumulation of H_2 gas in the Process Vessels or other flammable vapors from organics contained in the wastes. Aqueous radioactive waste in the SWPF will generate dissolved radiolytic H_2 as a function of its temperature and chemical make-up. In a vessel with passive or active ventilation, an equilibrium H_2 (or other combustible gas) concentration will be established in the liquid and in the vessel vapor space.

During normal operation, the combination of ADS and PVVS maintain vapor space concentrations below 25% of CLFL. If the tanks are not agitated for prolonged periods, some forms of radioactive waste in the SWPF processes (i.e., settled MST/sludge slurry) may generate significant quantities of trapped radiolytic H_2 bubbles within a layer of settled solids. If the waste is subsequently agitated by equipment operation or a seismic event, the H_2 released into the vessel vapor space could reach flammable concentrations. Calculation, S-CLC-J-00042, *SWPF Process Vessel Air Purge Rates*[63], has determined the air purge rate required for each vessel to prevent that vessel from reaching the CLFL. This calculation shows that the process design described below meets the intent of NFPA 69[62] for deflagration prevention by combustible concentration reduction.

To minimize this hazard, additional design features have been provided to reduce the H_2 gas (or other combustible gas) accumulation in the vessels. An ADS was added to control H_2 gas accumulation. Dilution air piping from a location external to the Process Cell to a nozzle located on the vessel head permits the introduction of forced dilution air into the tank vapor space. A riser connects the tank vapor space to the PVVS header. Except for the Solvent Drain Tank (TK-208), a process vessel vent orifice is provided to maintain vapor space less than 25% of the CLFL, assuming a constant vacuum pressure in the PVVS header. The ADS provides sufficient air flow to the Solvent Drain Tank (TK-208) to maintain the vapor space below 25% of the CLFL. Selected Process Vessels are equipped with an APA that 1) mixes the waste and treatment chemicals to enhance process reactions 2) ensures process sample consistency, and 3) prevents the accumulation of concentrated wastes in the Process Vessels. For vessels containing MST/sludge slurry, the APAs minimize the potential for trapping H_2 and provide a mechanism for releasing trapped H_2 from the liquid waste. The APA and piping through the cell walls are designed to PC-3 criteria. Temporary air compressors can be connected to the APAs and mixing of the tanks can be accomplished after a seismic event.

Ignition sources are limited within the Process Cell area by the reduced amount of electrical equipment, such as rotating equipment and electric motors. There are low voltage, low amperage thermocouples in process tanks. Also, Solvent Drain Tank (TK-208) has an interface level detector. Camera ports are available for insertion of cameras in the cells (but not into the sumps).

The electronic circuitry in the cameras will consist of explosion-proof or non-incendiary components having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of flammable gases, as required by NFPA 70[61], for Class I, Division 2, hazardous locations. The ventilation system will also provide dilution of combustible vapors during a loss of normal power.

With the exception of the Solvent Drain Tank (TK-208) discussed above, the PVVS exhaust system and other mitigating design features described above, along with monitoring and sampling provisions, are provided to maintain combustible concentrations of H_2 or any other flammable gases below 25% of the CLFL under normal operating conditions, in accordance with Section 6.3.1 of NFPA 69[62]. A loss of power would cause the PVVS and PBVS to stop. In this case, the ADS could displace gases into the cell, but these vapors would be below the CLFL. Although a build-up of H_2 gas is unlikely, the process vessel cell area has been classified as a Class I, Division 2, hazardous location as a DID measure to eliminate ignition sources (see previous discussion regarding overall H_2 generation and mitigation). This classification also improves the HPR status of the facility.

Another hazard is the solvents in the Process Vessels. If a leak occurs from the vessel into the cell, each cell is exhausted through HEPA filters and to the stack to prevent vapor accumulation in the cells. Leak detection and a sump level indication permit early detection and removal of any spills.

The Process Cell area is considered an unoccupied dark cell. Automatic suppression systems have not been provided for this area. Equivalent protection is provided in this area based on the fact that the area is normally unoccupied and contains limited combustibles. Ignition sources are excluded from the design and, as an unoccupied area, transient combustibles are controlled or prevented by Work/Job Hazard Analysis should this area be entered after hot operations begin. The Process Cells are also separated from other areas of the building by two-hour fire-rated barriers, which will prevent the spread of fire from other areas. An equivalency request, F-ESR-J-00002[56], (DOE approval letter, SWPF-07-252, *DOE Approval of Equivalency Requests F-ESR-J-00001 and F-ESR-J-00002*[64]) has been approved by the Authority Having Jurisdiction for not providing automatic sprinkler protection in this area.

3.2.4 Fire Area 2 – Alpha Strike Process Pump and Valve Galleries, West CSSX Tank Cell, and Miscellaneous Areas

3.2.4.1 North ASP P&VG

The North ASP P&VG is adjacent to and north of the Process Vessel Cells at the 100-ft elevation. The gallery labyrinth walls and ceiling are constructed of reinforced concrete for shielding purposes. Each of the six north ASP P&VG has an electric hoist bridge crane for maintenance activities.

Pumps and valves used to transfer process waste in and out of the Process Vessel Cells are located in the North ASP P&VG. The WTE routes all transfer lines for waste feed, MST/sludge, and strip effluent into or out of the Process Building. The waste transfer pumps and associated valves used

in transferring waste between Process Vessels or from the WTE are located inside the pump and valve labyrinth enclosures in the ASP P&VG. Strip effluent is transferred out through the WTE but pumps are located in CSSX P&VG. Sump level detectors provide an interlock function to stop liquid additions from the transfer pumps. Also, the sump level detectors and transfer pumps will control potential spills and other liquids that may be associated with maintenance.

The electric hoist bridge cranes in each North ASP P&VG are used to move pumps and valves or other heavy equipment within the labyrinth and for loading and unloading carts to transfer items in or out of the North ASP P&VG. The electric components in the crane's hoist meet the requirements of NFPA 70[61], and contain National Electrical Manufacturers Association Rated or UL Listed components for electrical safety. Prior to performing maintenance, the waste transfer pathway containing the affected component is first flushed and drained. This should then allow for direct contact-handled maintenance inside the labyrinth enclosure.

The North ASP P&VG combustible loading is expected to be low to moderate. The area contains mostly pumps, motors, instruments, and piping. Electric cables in the labyrinths are contained in conduits and are not expected to contribute to the combustible load in the area. Electric cables in the labyrinth corridors are in cable trays. There are low quantities of combustibles in this area.

Automatic suppression has been provided for the Pump and Valve Operating Area in accordance with the Ordinary Hazard, Group 2 requirements of NFPA 13[26]. In North ASP Labyrinths 3, 4, and 5 (Rooms 131B, 131C, and 131D), a deluge system has been provided for each of these three rooms. These rooms are considered high radiation areas. These systems were provided to eliminate the Teflon-coated Belleville springs used in all automatic sprinklers. Teflon deteriorates over time when exposed to radiation. The deluge systems are activated by linear heat detection. Each room contains six open sprinklers. A fire associated with these relatively small quantities of combustibles is expected to be isolated within the area of origin and be controlled by the automatic sprinkler system. Drainage from a sprinkler discharge will be through the labyrinth sumps and corridor floor drains. See the discussion in Section 3.2.2.2.

3.2.4.2 South ASP and CSSX P&VG

This Area is adjacent to and south of the Process Vessel Cells, and is separated from the adjacent areas of the Process Building by reinforced concrete construction with a minimum two-hour fire-rating. Automatic suppression has been provided for the Pump and Valve Operating Area in accordance with the Ordinary Hazard, Group 2 requirements of NFPA 13[26]. In CSSX Labyrinth 2 (Room 136B) a deluge system has been provided since this room is a high radiation area. This room contains a small deluge system with two open sprinklers. The system is activated by linear heat detection. Drainage from a sprinkler discharge will be through the labyrinth sumps and corridor floor drains.

The South ASP P&VG is located adjacent to the Process Cell area, directly below Cell Inlet Air HEPA Filter Room #2. The gallery walls and ceiling are constructed of reinforced concrete, similar to the North ASP P&VG. The South ASP P&VG includes the Wash Water transfer pumps, the Solvent Drain Tank pumps, and the Alpha Sorption Drain Tank transfer pumps.

The South ASP P&VG combustible loading is low. The area contains mostly pumps, motors, instruments, and piping. Electric cables are contained in conduits and are not expected to contribute to the combustible load in the area. There is a potential for fire involving the combustible organics or solvents associated with the adjacent Process Vessels. This would result from a pipe rupturing or transfer pump leaking material into the area or from maintenance activities. This concern is mitigated by the sump level detectors that provide an interlock function to stop liquid additions from the transfer pumps. Also, the sump level detectors and transfer pumps will control potential spills and other liquids that may be associated with maintenance.

The CSSX P&VG and Sample P&VG (100-ft elevation) are directly below the Contactor Support Floor. The general layout of this gallery includes reinforced concrete labyrinth walls, forming pump and valve enclosures, and also sumps with leak detection. Because each waste transfer pathway within an enclosure can be flushed, pumps can be disconnected and removed by hands-on maintenance. Personnel ingress and egress for this area is located on the east end. An Emergency Exit Only exit to Stairwell #4 is provided at the west end of the CSSX P&VG. This stairwell meets the required two-hour fire-resistive rating.

3.2.4.3 West CSSX Tank Cell

The West CSSX Tank Cell is separated from the East CSSX Tank Cell by a two-hour concrete fire barrier wall. The east side contains the higher-activity tanks and the west side contains tanks of lower activity. The cells are constructed with reinforced concrete floors and walls and stainless steel liners. A personnel access door is provided at the west end of the West CSSX Tank Cell.

Limited access is provided on the west side of the East CSSX Tank Cell to allow for maintenance of the Strip Effluent Coalescer media. The head of the Strip Effluent Coalescer is accessible from the West CSSX Tank Cell through the dividing wall between the two CSSX Tank Cells. Maintenance on the Strip Effluent Coalescer media is expected to be required on an infrequent basis, thus limiting transient combustibles that might be used during maintenance.

The east and west sides of the CSSX Tank Cell each have a designated sump and level instrumentation. The CSSX sumps normally contain process water to provide a liquid seal for the Process Vessel overflows. The sumps are evacuated by the CSSX Tank Cell Sump Transfer Pump to the Solvent Drain Tank (TK-208) and an overflow to the Solvent Drain Tank (TK-208) is provided.

The concrete cell floor is provided with a stainless steel liner that extends above the cell floor to provide liquid retention for the inventory of all aqueous wastes and solvent in the CSSX process equipment and tanks in this Cell. In addition to the Strip Effluent Coalescer media, equipment in the West CSSX Tank Cell that requires periodic maintenance includes valves associated with the Barium-137 Decay Tank (BDT) (TK-206), Strip Effluent Coalescer Pumps and associated valves, and the SHT (TK-202) thermocouple. Non-routine ingress and egress for the West CSSX Tank Cell is from the CSSX P&VG through an airlock.

Similar to the Process Cell vessels, the CSSX Tank Cell vessels have the potential for an accumulation of H_2 gas or other flammable vapors from organics contained in the wastes. During normal operation, the combination of: 1) the PVVS flow through the tanks via an inlet orifice from the cell, and 2) dilution air supplied to the tanks by the ADS are sufficient to maintain the flammable vapor concentration in the tank headspace below 25% of the CLFL. These systems meet the intent of NFPA 69[62] for deflagration prevention by combustible concentration reduction. The ADS by itself is sized to provide a rate of airflow sufficient to maintain the flammable vapor concentration in each tank headspace below the CLFL. For tanks designed without an inlet orifice from the cell (i.e.; the SHT (TK-202), Solvent Strip Feed Tank (TK-217), and DSS Coalescer) the ADS flow is set to keep those tanks below 25% of the CLFL. In the event that PVVS is shutdown, some flammable vapors will escape into the surrounding cell from those tanks with inlet orifices, but the concentration of those flammable vapors will be below the CLFL due to the action of the ADS.

The electrical systems within the West CSSX Tank Cell area are unclassified in accordance with NFPA 70[61]. This determination was made based on the fact that small amounts of hydrogen are made during normal operation, but these gases will not accumulate to the point of flammability. This is discussed in detail in 00-700-14618, *Classification of Salt Waste Processing Facility (SWPF) Electrical Area*[65].

A spill of solvent or strip effluent could result from a breach in the cell process piping. Even if the entire cell sump volume below the overflow were filled with the worst case waste, the time for the cell to reach flammable conditions (assuming no dilution from the ADS, PVVS, or PBVS) would be longer than four years (see 00-700-14618[65]). Accounting for the breathing effects of diurnal atmospheric pressure changes results in an equilibrium hydrogen concentration of much less than the 39% of Lower Flammability Limit calculated for the East CSSX Tank Cell. Thus, a cell explosion is not considered credible.

Another potential hazard associated with solvent extraction is a “red oil” explosion. Red oil is a substance that can form when an organic interacts with HNO_3. Red oil is formed when the organic, TBP, comes in contact with concentrated HNO_3 (10 moles per liter) at temperatures above 248°F (120 degrees Celsius [°C]). Red oil is relatively stable below 266°F (130°C), but can decompose explosively when its temperature is raised above 266°F (130°C). TBP is not used in the CSSX process; however, a remote possibility exists for the SWPF to receive a waste transfer from the Tank Farm containing concentrations of TBP.

The potential for a red oil explosion in the CSSX process is mitigated by the fact that the highest concentration of HNO_3 (0.05 moles per liter) used in the CSSX process is well below the highest concentration required for red oil formation. Additionally, the CSSX process temperatures are maintained at 68°F to 102°F (20°C to 39°C), which are well below the threshold of 248°F (120°C) required for red oil formation or explosion.

Automatic suppression has been provided for this area in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. The sprinkler piping and sprinklers in this area are stainless steel because of the potentially corrosive environment. Drainage from a sprinkler discharge will

be through the sump in the room, South ASP P&VG corridor floor drains, and the Stair 4 floor drain.

3.2.4.4 Material Staging and Storage Area

The Material Staging and Storage Area is located within the concrete central process area adjacent to and east of the P&VGs and Process Cells. This area is separated from adjacent areas of the Process Building by reinforced concrete construction with a minimum two-hour fire-rating and includes a controlled entry area, Waste Storage Areas #1, Contactor Rebuild Area, Filter Drop Area, Drum Off/ Decon Area, and an equipment lift for transferring materials to the 139-ft and 116-ft elevations. The equipment lift shaft is a two-hour rated shaft. Access to and from the South ASP P&VG Corridor and the AFF is located on the south end of the area. Normal ingress and egress from this area are provided by doors on the north and east sides leading to the Administration and Support Area of the facility. This Fire Area is protected by a wet-pipe sprinkler system. Drainage from a sprinkler discharge will be through the floor drains in each room.

3.2.4.5 Back-up Air Storage and Safe Shutdown Panel Room

The Back-up Air Storage is located at the west end of the facility. This area is separated from the Process Vessel Cell Area by reinforced concrete construction with a minimum two-hour fire-rating. The Back-up Air Storage contains the back-up ADS air receivers. This room is accessible only from a door on the outside of the building. This area is protected by a wet-pipe sprinkler system. Drainage from a sprinkler discharge is not a concern in this area since there is no radioactive material in the room.

The Safe Shutdown Panel Room is located at the west end of the facility. This area is separated from the Process Vessel Cell Area by reinforced concrete barriers with a minimum two-hour fire-rating. The Safe Shutdown Panel Room contains the back-up controls to safely shut down the facility if the Control Room is unavailable. This room is accessible only from a door on the outside of the building. This area is protected by the pre-action sprinkler system from the Control Room. Drainage from a sprinkler discharge is not a concern in this area since there is no radioactive material in the room.

3.2.4.6 Waste Transfer Access Room

The Waste Transfer Access Room is accessible only from a door on the west side of the building. This room contains valve actuators for controlling the waste transfer valves in the WTE below. This room is protected by automatic sprinklers.

3.2.4.7 Stairwells and Equipment Lift

All four stairwells and the Equipment Lift are shafts and are separated from all floors by two-hour rated barriers. They are included in this fire area for convenience. The areas are protected by automatic sprinklers. The exterior stairs on the west end of the building have floor drains to prevent water from escaping the building.

3.2.5 Fire Area 3 – Control Room and Information Technology Server Room

The Control Room and IT Server Room are located north of the Process Cell area, within the shielded process area of the building, and are separated from other areas of the Process Building by reinforced concrete construction that is designated as having a two-hour fire rating. Also included within this Fire Area are the Shift Supervisor's Office, UPS Room, and a unisex toilet. The fire hazards associated with the Control Room and IT Server Area are Control Room electronic equipment and computers. Other combustibles will be minimized. In accordance with NFPA 801[38], NFPA 75, *Standard for the Protection of Information Technology Equipment*[66], was considered. Based on the risk factors in Chapter 4 of this standard, life safety aspects of the function (e.g., process controls), fire threat of the installation to the occupants or the property, economic loss from loss of function or loss of records, and economic loss from value of equipment, NFPA 75[66] was not applied to the control room and the IT server room.

This Fire Area is protected by a pre-action sprinkler system, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. The sprinkler system in these rooms are installed to meet the intent of Section 8.14.10 of NFPA 13[26] and Article 110.26 (F)(1) of NFPA 70[61], which require sprinkler protection for electrical equipment while providing protection of the equipment against possible leaks. A smoke detection system has been provided in accordance with NFPA 72[42] for all the rooms to activate the pre-action system. The smoke detection system will serve as a DID measure to provide early warning of a fire. This helps the facility achieve an HPR status. Drainage from a sprinkler discharge is not a concern in this area since there is no radioactive material in the room. Normal ingress and egress from this area is provided by a door on the north side leading to the FSA of the building.

The main FACP is located in the Control Room. The FACP in the Compressor Building and the NGS Building are connected to the main FACP on a network loop. A detailed description of the fire alarm system is found in F-SD-J-00001[43].

3.2.6 Fire Area 4 – North and East Facility Support Area

This Fire Area is separated from other areas of the Process Building by reinforced concrete construction with a minimum two-hour fire-rating. The East FSA is separated from the AFF by a two-hour fire barrier gypsum board wall. The North FSA includes the administrative offices, electrical, mechanical equipment rooms, and the Radiological Control Support Area on the north side of the P&VG at the 100-ft elevation. A one-hour fire-rated corridor is included in this Fire Area and extends in an east-west direction on the north side of the Process Building. The corridor provides access to the Electrical Room, Control Room, Mechanical Room, offices, break room, Radiological Control Office, and showers and locker rooms. This corridor leads into the Radiological Control Support Area, which includes storage area for radioactive sources and other instrumentation. A portion of this corridor is a two-hour corridor that functions as the protected exit enclosure from the bottom of Stairway #2 to the exit discharge to the outside.

Another one-hour fire-rated corridor extends in a north-south direction and provides access to the Loading Dock, Calibration and Testing Shop, Maintenance Shops, and foremen's offices located in the East FSA on the east side of the Process Building.

The FSA is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. Drainage from a sprinkler discharge is not a concern in this area since there is no radioactive material in the room. The Electrical Room is protected with a pre-action sprinkler system installed to meet the intent in Section 8.14.10 of NFPA 13[26] and Article 110.26 (F)(1) of NFPA 70[61], which require sprinkler protection in Electrical Rooms while providing protection of the equipment against possible leaks. As with the IT Server Room and Control Room, a smoke detection system has been provided in accordance with NFPA 72[42] to activate the pre-action system in the Electrical Room. This detection system is expected to provide early warning for these rooms as a measure to reduce the possibility of an undetected fire within the cable-laden enclosures. Portable extinguishers are available throughout the facility.

The fire hazards associated with the FSA are the electrical switchgear and Motor Control Centers, HVAC fans, and equipment. Other combustibles include furniture, office material, and personal protective equipment. Combustible/flammable liquids will not be stored outside of flammable/combustible liquid storage cabinets. Small quantities of flammable/combustible liquids may be brought into the area for maintenance activities. Gasoline-powered equipment containing not more than 5 gallons of fuel may be brought into the maintenance shops. When a truck unloads at the loading dock, it is possible for up to 300 gallons of diesel fuel to be present temporarily inside a U.S. Department of Transportation-approved vehicle tank in the room. The truck loading dock is separated into a non-rated gypsum wall board room. All containers of flammable and combustible liquids will be stored in UL-Listed flammable and combustible liquid storage cabinets after use. Transient combustibles may include low quantities of trash awaiting disposal, paper products, etc. The locker rooms and Radiological Control Support Area contain lockers or bins for clothing storage, and could contain bags of used clothing awaiting disposal. The walls between rooms in this fire area are constructed with non-combustible materials.

Since the building is protected with sprinkler systems, the corridors in an F Occupancy (see Table 1016.1 of IBC-2003[21]) or an Industrial Occupancy (see Section 40.3.6 of NFPA 101[24]) are not required to be rated. However, the corridors in the FSA are a minimum one-hour rated. The protected corridors exceed the minimum code requirements and help the facility achieve an HPR status. Also, the exit discharge from Stair #2 is two-hour rated from the bottom of the stairwell through the North FSA to the outside. This protected exit enclosure is required by code and is discussed in Section 3.4.

Total combustible loading in this area is estimated to be in low to moderate quantities. A fire originating in this area of the building is expected to be controlled by the automatic sprinklers in the area.

3.2.7 Fire Area 5 - Exhaust HEPA Filter and Fan Rooms

The Process Building Exhaust Air HEPA Filter Room and Exhaust Fan Room are located above the North ASP P&VG at the 116-ft elevation. The Process Building Exhaust Air HEPA Filter Room contains four HEPA filter housings. Each filter housing contains two stages of HEPA filters in series. Three parallel filter housings and internal filters comprise the Process Building exhaust filtration train. The standby filter housing provides standby capacity so maintenance and filter change-out can be performed without loss of filter capacity. The standby filter housing can be placed in service if any of the three filter housings require filter replacement or maintenance. The filtration train receives air from HVAC Zone 1, prior to being exhausted to the SWPF stack by the Process Building exhaust fans. The Process Building Exhaust HEPA Filter Room has an emergency exit on the west end. The east end of the Process Building Exhaust HEPA Filter Room is connected to the Exhaust Fan Room. Emergency egress from the Exhaust Fan Room is at the east end.

This Fire Area is separated from adjacent areas in accordance with DOE-STD-1066-99[15] by reinforced concrete construction designated as two-hour fire-rated barriers. The walls, floor, and ceiling are constructed of reinforced concrete. This Fire Area is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. In addition, sprinklers are provided under ductwork that exceeds 48 inches in width, and a manual water spray system is installed in each final exhaust HEPA filter housing as discussed in Section 3.2.2. Drainage from an overhead sprinkler discharge will be through the floor drains at the bottom of Stair 1 and Stair 2. If the manual spray system is discharged into a HEPA Filter, the HEPA enclosure will fill and the water will eventually begin to fill the ducts. For drainage purposes only, the 6 nozzles in one of the PBVS Final Exhaust HEPA Filters will discharge approximately 89 gpm into the enclosure. A 30 minute discharge of these nozzles will be 2,670 gallons. This may fill the 761 cubic ft (5,700 gallon) HEPA enclosure and spill into the ductwork. Regardless, the water will be contained in the HEPA enclosure and ductwork, The water could be drained to a floor drain using the drain port at the bottom of the enclosure.

The fire hazards in this Fire Area are exhaust fan equipment and electric motors. Transient combustibles would be expected to consist of materials brought in for maintenance activities (e.g., rags, plastic bags, filters during change-out). The amounts of transient combustibles would be in low quantities. There are no combustible or flammable liquids stored in this Fire Area. Total combustible loading in this area is expected to be in low quantities. A fire originating in this area of the Process Building would be expected to be controlled by the automatic sprinklers in the area.

The Exhaust HEPA Filter Room and Exhaust Fan Room are designed to be Radiation Areas, containing radioactive contamination on the filters. The anticipated fire is a small or incipient type that may be extinguished with portable fire extinguishers. The drainage system in this area is designed to handle potentially contaminated water from sprinkler discharge, in accordance with NFPA 801[38].

A small section of the two-hour rated floor fire barrier extends around a transfer air duct from the top of the 116-ft Level floor to the CPA wall where a fire damper is located (See A-A1-J-00010 for this detail). Section 711.3.2 of the IBC-2003[21] states that access doors in horizontal fire rated assemblies shall be tested in accordance with American Society for Testing and Materials (ASTM) E119, *Standard Test Methods for Fire Tests for Building Construction and Material*[67].

3.2.8 Fire Area 6 - Contactor Support Floor and Operating Deck

The Contactor Cell is located adjacent to and south of the Process Cells, directly over the CSSX P&VG. This Fire Area is sub-divided into the Contactor Support Floor at the 116-ft elevation and the Contactor Operating Deck at the 124-ft elevation. The cell walls and ceilings are constructed of reinforced concrete for shielding purposes, fire resistance, and NPH protection. The floor between the Contactor Support Floor and the Contactor Operating Deck is a steel grated floor around the contactor drive shafts, so the two rooms are in the same air space.

The Contactor Cell contains 36 centrifugal counter-current flow contactors. The 16-stage Extraction Unit and 2-stage Scrub Unit are in an east-west linear array just north of the cell centerline. The 2-stage Caustic Wash Unit and 16-stage Stripping Unit are in an east-west linear array just south of the cell centerline. Process piping connections are welded to the contactor bodies, which are supported by structural steel attached to the concrete Contactor Support Floor at the 116-ft elevation.

Contactor testing and operating experience indicate that motor failure and bearing failure are the dominant contactor failure mechanisms. The contactor motors are installed above the steel grated floor to permit maintenance on the motors. A monorail hoist attached to the ceiling supports installation and removal of the contactor components. Normal ingress and egress for the Contactor Operating Deck are by a doorway from the CSSX Tank Cell Operating Deck and Contactor Drop Area. An exit to Stairwell #4 is provided at the west end of the CSSX Tank Cell Operating Deck. Additional egress is provided to the east through the CSSX Contactor Drop Area to Stairwell #2. There is an Equivalency (see SWPF-07-252[64]) associated with the egress from the Contactor Operating Deck. See Section 3.4.4 for a full discussion of this condition.

Automatic sprinklers are required to be installed at the deck of the Contactor Operating Deck, according to Section 8.5.5.3.1 of NFPA 13[26]. Deluge systems are installed below the open steel grate deck. The sprinkler systems in the room are divided into two sections, east and west. For each section, activation of an automatic sprinkler at the ceiling of the Contactor Operating Deck will trip the corresponding deluge system below the deck. For example, a fire at the east end of the room would activate sprinklers at the ceiling of the east end of the room and trip the deluge system below the operating deck on the east end. The hydraulic design area for the sprinkler system in this room is a 1,500 ft^2 area located in the center of the room. This causes both the east and west deluge systems below the operating deck to be activated, which results in the highest flow demand for this room (and for the building). Sprinkler system discharge will be contained in this Fire Area to prevent the spread of contamination, in accordance with NFPA 801[38]. A 3-inch drain will route sprinkler discharge water from the bottom of the Contactor Cell to the East CSSX Tank Cell sump, SMP-217. The electrical systems in the Contactor Cell area are not classified as hazardous

locations in accordance with NFPA 70[61]. This determination was made based on the fact that small amounts of H_2 are made during normal operation, but these gases will not accumulate to the point of flammability. This is discussed in detail in 00-700-14618[65].

3.2.9 Fire Area 7 – Inlet HEPA Filter Room, contactor Drop Area, CSSX Tank Cell Operating Deck

3.2.9.1 Cell Inlet HEPA Filter Room #2 and Contactor Drop Area at 116-ft Elevation

Cell Inlet HEPA Filter Room #2 and the CSSX Contactor Drop Area are located east of the CSSX Contactor Cell. Cell Inlet HEPA Filter Room #2 contains the air inlet HEPA filter for the CSSX Tank Cell and the FFT-A Cell. The CSSX Contactor Drop Area is south of the Filter Room and contains the DSS Coalescer. A floor hatch at the 116-ft elevation allows a hoist to lower contaminated contactor components into the South ASP P&VG corridor/drop area (100-ft elevation). This hatch through the floor is a two-hour rated configuration.

East of the HEPA Filter Room #2 is the Contactor Variable Frequency Drive Room and Contactor Staging Area, which are also included in this Fire Area.

Normal ingress and egress for this area are provided through Stairway #3 at the east or through the CSSX Tank Cell Operating Deck at the 124-ft elevation to Stairway #4 on the west. Emergency egress from this area is through Stairway # 2 or #4.

This Fire Area is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. Drainage from a sprinkler discharge will be through the floor drains at the bottom of Stair 2 and Stair 3 in accordance with NFPA 801[38].

3.2.9.2 HEPA Filter Storage and Staging Area and Filter Drop Access Area at 116-ft Elevation

The Filter Storage Room and ASP Filter Cask drop access area are located at the east end of the CPA at the 116-ft elevation. This Fire Area is located adjacent to the Exhaust Fan Room and the Process Cells. The Filter Storage Room contains clean HEPA filters for the Process Building exhaust filtration trains. The ASP Filter Cask drop access area is provided with removable access covers in the floor and ceiling, which allow lowering of the ASP Filter Cask from the Operating Deck at the 139-ft elevation to the Material Staging and Storage Area at the 100-ft elevation. The removable covers in the floor are two-hour rated to match the floor rating. The removable covers are designed to meet the requirements of NFPA 220[23], as a qualifying fire barrier.

Normal ingress and egress for this area are provided through Stairway #2 at the northeast or through the CSSX Contactor Staging area to Stairway #3 on the southeast. Emergency egress is provided through the Exhaust Fan Room and HEPA Filter Room at the west end to Stairway #1 or to Stairway #2.

This Fire Area is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. Drainage from a sprinkler discharge will be through the floor drains near the bottom of Stair 2 and Stair 3.

3.2.9.3 CSSX Tank Cell Operating Deck

The CSSX Tank Cell Operating Deck is located above the CSSX Tank Cells at the 124-ft elevation. Personnel entry to the East CSSX Tank Cell is not expected during the lifetime of the facility. However, means for non-routine access and egress for the East CSSX Tank Cell is provided through a shielded plug/access hatch manway in the floor of the CSSX Tank Cell Operating Deck with an installed monorail hoist to support shield plug removal if needed. This area also includes the Spare Contactor Storage Area at the 124-ft elevation, which is open to the Contactor Drop Area below. Drainage from a sprinkler discharge will be through the floor drains near the bottom of Stair 3 and at the bottom of Stair 4.

3.2.10 Fire Area 8 - Process Vessel Cell Operating Deck

The Operating Deck is located above the Process Vessel Cells at the 139-ft elevation. The Operating Deck provides an area for remote removal and replacement of equipment within the Process Vessel Cells that is not designed for the life of the plant (e.g., extended sleeve valves, cross-flow filter tube bundles, tank thermocouples). Personnel access into the Process Vessel Cells should not be required over the life of the plant.

The Alpha Sorption Drain Tank Cell below the Operating Deck contains the Alpha Sorption Filters. The SSRT/Wash Water Hold Tank Cell contains the Washing Filter. Filter bundles can be removed through removable shield plugs, using a Filter Cask. Removable shield plugs are also provided over the instrument sensing devices and valve internals to allow access for remote removal and replacement of these components. The Operating Deck floor also has a removable hatch to allow the Filter Cask to be lowered through the 139-ft level and 116-ft level floors into the Filter Drop Area of the Material Staging and Storage Area on the 100-ft level, where it will await transport out of the structure through the Truck Bay. These hatches are two-hour fire-rated to separate Fire Areas above and below. Automatic sprinkler protection is required below the hatches, even though they are removable. The sprinkler system has been designed to provide protection by locating quick response sidewall sprinklers in the room below to protect the pockets created by the hatches. All sprinklers in these rooms below are quick response to meet Section 8.6.7 of NFPA 13[26].

The Operating Deck bridge crane can be either locally controlled via a radio frequency control system or remotely operated. The crane has television cameras.

Filter Vent Relief and Blowdown Enclosures, and Pulse Mixer Enclosures are located on the Operating Deck. The Filter Vent Relief and Blowdown Enclosures allow access for maintenance on the valves that control the filter back-pulsing operations. The Pulse Mixer Enclosures allow access for maintenance of the valves that control air pulsing and venting of the pulse pots inside the Process Vessels. Because the piping systems and valves within these enclosures are potentially

contaminated, the enclosures provide a measure of contamination control and shielding for routine operations in the Operating Deck.

This Fire Area is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. Also, sprinklers are provided in the Filter Vent Relief and Blowdown Enclosure and the Pulse Mixer Enclosures. Penetrations were designed in the top of these enclosures to allow the installation of sprinklers. Drainage from a sprinkler discharge will be through the floor drains near the bottom of Stair 2 and Stair 3.

3.2.11 Fire Area 9 – HEPA Filter Rooms and Laboratory Hot Cell Exhaust Room at 139-ft Elevation

The PVVS/PMVS HEPA Filter Room and Cell Inlet Air HEPA Filter Room #1 are located at the 139-ft elevation, above the Process Building Exhaust Air HEPA Filter Room.

Ducted exhaust air flows from the North P&VG Labyrinths into Cell Inlet HEPA Filters and on to the dark cells. Transfer exhaust air flows from the Process Building Exhaust Filter Room, the PVVS/PMVS HEPA Filter Room, and the Analytical Laboratory to Cell Inlet Air HEPA Filter Room #1 then through Cell Inlet HEPA filters and on to the dark cells.

The PVVS/PMVS HEPA Filter Room contains the filter housings for two filtration trains for the PVVS and two filtration trains for the PMVS. One filtration train for each system is redundant, so maintenance and filter change-out can be performed without loss of ventilation exhaust. The PVVS filters receive air from the Process Vessels. The filtered air is exhausted by the PVVS exhaust fan located in the PVVS/PMVS Fan Room. The filtered air from the PMVS is exhausted by the PMVS exhaust fan, which is also located in the PVVS/PMVS Fan Room. Exhaust from the PVVS and PMVS is discharged to the SWPF Exhaust Stack. Egress from the room is provided by Stairway #2 at the east end and through Cell Inlet HEPA Filter Room #1 to Stairway #1 on the west end.

Cell Inlet HEPA Filter Room #1 contains the air inlet HEPA filters for the Process Vessel Cells not serviced by HEPA Filter Room #2. Access to Cell Inlet Air HEPA Filter Room #1 is provided from Stairway #1 and from Stairway #2 through the PVVS/PMVS HEPA Filter Room.

This Fire Area is separated from adjacent areas by reinforced concrete construction with a minimum two-hour fire-rating. The steel members supporting the roof are required to be one-hour fire rated by Table 601 of IBC-2003[21]. These steel members are provided with one-hour protection. This Fire Area is protected throughout by wet-pipe sprinkler systems, designed, and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26]. Drainage from a sprinkler discharge will be through the floor drains at the bottom of Stair 1 and near the bottom of Stair 2.

The fire hazards in this Fire Area are the same as those for the HEPA Filter Rooms at the 116-ft elevation. The primary hazards in the area are exhaust fan equipment and electric motors. Electric cables are contained in conduits and are not expected to contribute to the combustible load in the area. Transient combustibles are expected to consist of materials brought in for maintenance

activities. The amounts of transient combustibles are in low quantities. As with the other HEPA Filter Rooms, no combustible or flammable liquids are expected to be stored in this Fire Area. Total combustible loading in this area is in low to moderate quantities. A fire originating in this area of the Process Building is also expected to be controlled by the automatic sprinklers in the area.

3.2.12 Fire Area 10 – Cold Chemicals Area

The CCA is on the southwest side of the Process Building adjacent to the CSSX Tank Cells at the 100-ft elevation, and provides space for tanks for receiving, preparing and storing process chemicals used in SWPF process operations. The chemical quantities in CCA exceed the Maximum Allowable Quantity per Control Area (threshold limits for area classification) in Table 307.7(2) of IBC-2003[21]; therefore, the CCA is classified as an H-4 Occupancy and is required to have Type II (111) construction, per Table 503 and Table 601 of IBC-2003[21]. Refer to Section 2.2 for additional explanation of this classification. All structural elements are of non-combustible materials and have a minimum fire-rating of one hour. Tanks and pumps for similar chemicals are grouped together inside concrete dike walls to control spills and prevent mixing of incompatible chemicals. The Filter Cleaning Acid Feed Tank (TK-106) and the Nitric Acid Receipt Tank (TK-304) are vented through the roof to the outside. The other CCA tanks vent to the building atmosphere through a tank-top overflow line. This Area also includes a Cold Chemicals Receiving Dock, Truck Ramp and Cold Chemicals Laboratory. Air is supplied to this normally occupied area by two Air Handling Units (AHUs), which draw air from the outside environment. Air is exhausted from the area by roof-mounted exhaust fans.

Most of the chemicals contained in the CCA are non-combustible liquids. As noted in Table 3-4, the Solvent Make-up Tank (TK-313) and the CSSX solvent recharge storage contain a four-component mixture composed of BOBCalixC6, Cs-7SB, TOA, and Isopar L. Although the flash point of the Isopar L is 144 ± 3 °F, the CSSX solvent has a flashpoint of 148 ± 1°F (see WSRC-TR-2006-00083, *Flash Point of CSSX Solvent*[68]). Either flash point meets the definition of a Class IIIA combustible liquid. A maximum of 660 gallons of Class IIIA combustible liquid is permitted to be stored in the CCA. A Class IIIA combustible liquid is defined by NFPA 30, *Flammable and Combustible Liquids Code*[69] as any liquid that has a flash point at or above 140°F, but below 200°F. A fire involving the contents of the Solvent Make-up Tank (TK-313) or drum storage area is fully expected to be controlled by the automatic sprinkler system in this area. The Solvent Recharge Storage (55-gallon drums) are contained in listed flammable liquid storage cabinets, in accordance with NFPA 30[69]. One flammable liquid storage cabinet, containing two 55-gallon drums of solvent or Isopar L (110 gallons), is stored in CCA. The remaining 55-gallons drums are stored in flammable liquid storage cabinets in the J-Area Warehouse.

It should be noted that a fire involving the solvent mixture could produce byproducts that contain small amounts of formaldehyde and hydrogen cyanide. The Cs-7SB modifier constitutes approximately 30% by weight of the total solvent mixture. The CSSX solvent fire byproducts were observed in combustion tests reported in Washington Savannah River Company (WSRC)-TR-2006-00171, *Solvent Fire By*-Products[70]. For an oxygen-deficient burn, no hydrogen fluoride (HF) was detected in the by-products, indicating the fluoro-hydrocarbon, Cs-7SB, does not burn. The

modifier appeared to simply concentrate during the fire. The Fire Department reviews the Material Safety Data Sheet/Safety Data Sheet of hazardous materials when developing the pre-fire plan. Table 3-3 shows the components of the CSSX solvent (see SPC-ME-6204-0005, *CSSX Solvent Mixing*[71]).

Table 3-3. Components of CSSX Solvent

Component	Composition	Amount in 100 Gallons (kg)(*)	Wt%
BOBCalixC6 (extractant)	Hydrocarbon	3.05	0.94
Cs-7SB (modifier)	Fluoro hydrocarbon	96.1	29.6
TOA (suppressant)	Tri-n-octylamine	0.402	0.12
Isopar L (isoparaffinic solvent)	Alkane Hydrocarbon	225	69.3
Notes: * Taken from SPC-ME-6204-0005[71]			

HNO_3, 20% by weight, is a Class 1 oxidizer, per NFPA 430, *Code for the Storage of Liquid and Solid Oxidizers*[72]; therefore, the basic requirements given in Chapters 4 and 5 of NFPA 430[72] are applicable to this area. The storage areas are diked to prevent leaks from one area flowing into an adjacent area containing incompatible materials. The HNO_3 is stored in the Nitric Acid Receipt Tank (TK-304), the Filter Cleaning Acid Feed Tank (TK-106) and the Nitric Acid Scrub Make-up Tank (TK-307). The caustic and solvent tanks are separated by dikes and are considered "cut off" from incompatible materials, as required by NFPA 430[72]. Table 307.7(1) of IBC-2003[21] states that Class 1 Oxidizers are unlimited when the building is protected by an automatic sprinkler system. This allows the building to be classified as an H-4 rather than an H-3 Occupancy per the IBC-2003[21].

The 50% sodium hydroxide (NaOH) in the Caustic Receipt Tank (TK-302) is corrosive. This tank volume exceeds the quantity for a single control area allowed by Table 307.7(2) of IBC-2003[21]. Table 307.7(2) of IBC-2003[21] allows up to 1,000 gallons of corrosive liquid in a sprinklered building. When the quantity exceeds this amount, the area is required to be classified as an H-4 Occupancy. The quantity of this tank is 9,600 gallons. Other tanks of lower concentration NaOH are also in this area. The storage areas are diked to prevent leaks from one area flowing into an adjacent area containing incompatible materials.

The oxalic acid ($H_2C_2O_4$) that is infrequently contained in the Filter Cleaning Acid Feed Tank (TK-106) is toxic. This tank volume exceeds the quantity for a single control area allowed by Table 307.7(2) of IBC-2003[21]. Table 307.7(2) of IBC-2003[21] allows up to 1,000 pounds of toxic liquid in a sprinklered building. For the allowable amount in gallons, the number in pounds is divided by 10 in accordance with Table 2703.1.1(2), note j of *International Fire Code* (IFC)-2003[73], to get 100 gallons. The quantity of this tank is 4,100 gallons so the area is correctly classified as an H-4 Occupancy. The $H_2C_2O_4$ and the incompatible HNO_3 are adequately separated as required by NFPA 1, *Uniform Fire Code*™[74] and NFPA 430[72].

The CCA is protected by a wet-pipe sprinkler system designed and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26], with a sprinkler density of 0.2 gpm/ft^2 over 1,500 ft^2. The actual quantities of chemicals are not considered large when in solution in CCA. As previously stated in Section 2.2, the contents are considered Ordinary Hazard Contents. Except for the two polyethylene water tanks (TK-301 and TK-312), all other tanks in CCA are stainless steel. The only combustible liquids in CCA are stored in small quantities of 110 gallons inside a flammable liquids storage cabinet (Isopar L) and 70 gallons in a stainless steel tank (CSSX solvent). The HNO_3 tanks are noncombustible containers and the Class 1 Oxidizer must be protected as a Class I Commodity according to Section 5.3 of NFPA 430[72]. The HNO_3 tanks are less than 12 ft in height and can be protected using an Ordinary Hazard Group 1 density according to Section 12.1.10 of NFPA 13[26]. The remaining liquids are considered hazardous because they are corrosive. These liquids are considered very dilute in strength, and become less corrosive with dilution. These dilute liquids are considered Low Hazard Contents and are protected by an Ordinary Hazard Group 2 sprinkler system.

Miscellaneous materials as well as process chemicals are brought to the facility at the Truck Ramp. Some materials may be temporarily stored on the Receiving Dock until dispositioned to a permanent location. The Truck Ramp, Receiving Dock, and the low bay rooms of the CCA are protected by a dry pipe sprinkler system.

This area is separated from the rest of the Process Building and the AFF by two-hour fire-rated barriers. The chemicals stored in the CCA are identified in Table 3-4. Drainage from a sprinkler discharge is not a concern in this area since there is no radioactive material in the room.

Table 3-4. Cold Chemicals Area Inventory

Tank Name	Tank No.	Maximum Volume (gallons)	Contents	NFPA Fire Hazard Class	IBC-2003[21] Hazard Designation
Scrub Make-Up Tank	TK-307	2,500	0.05M HNO_3	Non-Flammable/ Class I Oxidizer	Class I Oxidizer/ Corrosive
Solvent Make-up Tank	TK-313	70	0.007M BOBCalixC6, 0.75M Cs-7SB, and 0.003M TOA in Isopar L; May contain pure Isopar L as an option	Class IIIA (Combustible Liquid)	NA
Filter Cleaning Caustic Tank	TK-107	1,100	0.02M NaOH	Non-Flammable	Corrosive
Monosodium Titanate Storage	TK-311	1,000	150-200 grams per liter MST (consistent with X-SPC-J-00009, *Monosodium Titanate [MST]*[75])	Non-Flammable	NA
Caustic Receipt Tank	TK-302	9,600	50% NaOH (~19M)	Non-Flammable	Corrosive
Caustic Dilution Feed Tank	TK-108	9,600	1.66M NaOH	Non-Flammable	Corrosive
Caustic Make-Up Tank	TK-303	2,500	0.01M NaOH	Non-Flammable	Corrosive
Filter Cleaning Acid Feed Tank	TK-106	4,100	20 wt% HNO_3 (0.5M $H_2C_2O_4$ available as a substitute cleaning acid)	Non-Flammable/ Class I Oxidizer (Class IIIB ; Non-Flammable in solution)	Class I Oxidizer/ Corrosive (Toxic)
Nitric Acid Receipt Tank	TK-304	2,500	20 wt% HNO_3	Non-Flammable/ Class I Oxidizer	Class I Oxidizer/ Corrosive
CSSX Solvent Recharge Storage (two 55-gallon drum storage)	Flammable Liquid Storage Cabinets	110	0.007M BOBCalixC6, 0.75M Cs-7SB, and 0.003M TOA in Isopar L; May contain pure Isopar L as an option	Class IIIA (Combustible Liquid)	NA
Neutralization Tank	TK-317	650	Various liquid mixtures, including high concentrations of caustic or nitric acid	NA	Corrosive
Process Water Tank	TK-301	9,400	Water	NA	NA
Deionized Water Tank	TK-312	7,600	DI Water	NA	NA
Process Water Pressure Tank	TK-305	450	Water	NA	NA
Monosodium Titanate	55-gal. drums	NA	Slurry	NA	NA

3.2.13 Fire Area 11 – Alpha Finishing Facility

The AFF is located east of the CCA and contains diked process areas, an HVAC Room, and an Electrical Room. The diked process area of the AFF is accessed through a personnel airlock. This area of the Process Building contains grated walkways at the 100-ft elevation, with dike floors at approximately 95' elevation. The dikes are sized to confine the spilled volumes of the largest enclosed Process Vessels and are lined with an epoxy coating. This material meets the interior finish requirements of NFPA 801[38], which requires a Class I floor finish for interior floor finishes and a Class A finish for walls and ceilings.

The AFF has insulated steel panels for the siding on the exterior walls of the building. These panels are UL listed for Class A surface finishes and are specified to meet the requirements of NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*[76], which provides a fire propagation test method for non-load-bearing wall assemblies and wall panels made with combustible materials (usually combustible internal insulation) for exterior walls that are required to be non-combustible. This also meets the intent of NFPA 801, 5.5[38], which states that "Buildings in which radioactive materials are to be used, handled, or stored shall be fire resistant or noncombustible." Penetration seals in these panels ensure that the foam insulation is not exposed.

The structural steel in AFF is protected in accordance with Table 601 of IBC-2003[21] for this occupancy. The majority of exposed structural steel in AFF is protected with an intumescent coating. Since the top of the steel beams at the roof are not coated with the intumescent, the roof deck is protected with a UL tested mineral wool board design to create a complete two-hour fire barrier at the roof.

The AFF AHU supplies the building with outside air, conditioned to maintain the AFF as suitable for worker access and equipment function. Flow balancing between the supply and exhaust subsystems maintains the AFF at a negative pressure, which ensures that potentially contaminated air does not escape unfiltered from the building. The AFF HVAC System exhaust fans discharge to the SWPF Exhaust Stack.

The AFF is protected by a wet-pipe sprinkler system designed and installed in accordance with the Ordinary Hazard, Group 2, requirements of NFPA 13[26], with a density of 0.20 gpm/ft^2 over 1,500 ft^2. Drainage from a sprinkler discharge will be through the large sumps in the room. This area of the building is separated from the rest of the building by two-hour fire-rated fire barriers.

The AFF Area contains Process Vessels and associated filters, pumps, piping, and support equipment. Process Vessels include MST/Sludge Transfer Tank (TK-224) and FFT-B (TK-222) containing MST/sludge, and AST-B (TK-221) and IST (TK-207) containing Cs-depleted CSS and the DSSHT (TK-207) containing DSS. AFF also includes the lab waste collection tanks, Cleaning Solution Dump Tank-B (CSDT-A) (TK-103), and drain tanks.

Fire hazards associated with the AFF Area are those that would be associated with electric motors, pumps, and HVAC equipment. The combustible solvent is in solution in the tanks in this Area,

and no combustible/flammable liquids are expected to be stored or used in the AFF Area. Electric cables are mostly contained in conduits, with some portions being placed in open cable trays. There are cable trays in the electrical room.

Total combustible loading in this area is in low to moderate quantities. A fire originating in this Area is expected to be controlled by the automatic sprinklers in the area.

This Fire Area is partially a Radiological Area and is a potential contamination area. Sprinkler system discharge will be contained within the diked areas in accordance with NFPA 801[38].

Some forms of radioactive waste in the SWPF processes (i.e., settled MST/sludge slurry) may accumulate quantities of entrained (trapped) radiolytic H_2 that could result in flammable vapors collected in the tanks. The tanks in the AFF are purged with plant air to maintain the tank head space less than 25% CLFL. If the plant air failed, the time to reach CLFL was calculated in S-CLC-J-00033, *SWPF Time to Reach the Composite Lower Flammability Limit (CLFL) for SWPF Process Vessels*[77]. This calculation determined that the solvent normally contributes less to the time to CLFL than the H_2 primarily due to the limited volume of solvent in the vessels. Heat up of the process vessels due to external recirculation pumps was also determined to have a significant impact on the time to CLFL. For the vessels with large recirculation pumps, continued operation of the pumps can result in the vessel temperature exceeding the flash point of the solvent. At that point the vessel vapor contents could become flammable. To prevent this from occurring, the large external recirculation pumps are automatically tripped on high temperature in the filter loops. These controls will prevent the temperature from rising in the tanks and will maintain the vapors below the CLFL. This Area is not classified as Class I, Division 2, per NFPA 70[61], because these controls will prevent the tanks from reaching the CLFL under normal conditions.

3.2.14 Fire Area 12 – AFF HEPA Filter Room

The AFF HEPA Filter Room contains a two-stage HEPA filter enclosure for the AFF. The HEPA filter train consists of a prefilter and two HEPA filters in series to minimize radioactive emissions to the environment. Access to the HEPA Filter Room is provided by a doorway on the north side leading from the AFF Area or by an exterior exit on the south side of the facility that leads directly to the outside.

This Fire Area is separated from adjacent AFF areas by two-hour fire-rated barriers and is protected throughout by a wet-pipe sprinkler system. The AFF HEPA Filter Room has insulated steel panels for the siding on the exterior walls of the building. See the discussion above about this type of wall panels.

The fire hazards in this Fire Area are the same as those for the Process Building HEPA Filter Rooms. The primary hazards in the Area are electrical equipment. Cables are in conduits and trays. Transient combustibles may be brought in for maintenance activities and are expected to include plastic bags and filters during filter change-out. A clean-up activity is an abnormal condition requiring a special work procedure. This procedure will evaluate the required cleaning supplies and other hazards associated with the activity. The work would be controlled by this procedure.

As with the other HEPA Filter Rooms, no combustible or flammable liquids will be stored in this Fire Area. A fire originating in this Area of the AFF is also expected to be controlled by the automatic sprinklers in the area. Also similar to the PBVS HEPA Filter Room, a manual water spray system is installed in the final exhaust HEPA filter housing as discussed in Section 3.2.2. If the manual spray system is discharged into the HEPA filter, the HEPA filter enclosure will fill and the water will eventually begin to fill the ducts. For drainage purposes only, the 12 nozzles in the AFF Final Exhaust HEPA filter will discharge approximately 178 gpm into the enclosure. A 30 minute discharge of these nozzles will be 5,340 gallons. This may fill the 1,056 cubic ft (7,900 gallon) HEPA enclosure and spill into the ductwork considering the HEPA enclosure is not hollow. Regardless, the water will be contained in the HEPA enclosure and be drained to a floor drain using the drain port at the bottom of the enclosure.

This area also contains a floor drain to collect sprinkler system discharge in accordance with NFPA 801[38].

3.2.15 Fire Area 13 - Analytical Laboratory Area

The Analytical Laboratory Area is located at the 139-ft level south of and adjacent to the Operating Deck. Normal access to the Laboratory Area is provided via Stairwell #3 located on the east side of the facility, Stairway #4 on the west end (which provides direct access to the exterior of the building at the 100-ft elevation), or through a doorway to the Operating Deck. Emergency egress from the area is via Stairwell #4 or through the Operating Deck to Stairwell #2. Refer to Section 3.4.3 for a more complete discussion of egress from this area. This Fire Area includes the Organic Laboratory, Inorganic Laboratory, Radiochemistry Laboratory, Hot Laboratory (including Hot Cell), Manipulator Repair Room, Laboratory Storage, Laboratory Count Room, Laboratory Office, Laboratory Bottle Storage, and a unisex toilet. Appropriately placed eyewash/safety shower stations are provided in the Analytical Laboratory.

The Laboratory Areas are used to perform chemical separations and chemical and radiological analyses. Samples are contained and handled in accordance with the chemical and radiological hazards. Sample movement into and out of the laboratory areas is in accordance with the chemical and radiological hazards. The Analytical Laboratory hoods and glove boxes have a drain collection system for recovery of laboratory waste fluids. The laboratory floor and wall coatings meet the interior finish requirements of NFPA 101[24], NFPA 801[38], and DOE-STD-1066-99[15].

This Fire Area is separated from adjacent areas by reinforced concrete construction with a minimum two-hour fire-rating. The steel members supporting the roof are required to be one-hour fire rated by Table 601 of IBC-2003[21]. These steel members are provided with one-hour protection. Protection is provided throughout to achieve the required rating.

Combustible loading is expected to be typical for a minimal-hazard laboratory occupancy including furniture, metal cabinets, office material, and personal protective equipment. Combustible and flammable liquids will be used in small quantities and will be stored in approved, listed flammable liquid storage cabinets. Transient combustibles may include low quantities of trash, paper products, etc. There will also be small quantities of clothing storage in the laboratory

storage room and in radiological dress-out areas. The walls between rooms have a non-combustible construction. Total combustible loading in this area is estimated to be in moderate quantities as defined in NFPA 101; therefore, a fire originating in this area of the Process Building would be expected to be controlled by the automatic sprinklers in the area.

The physical characteristics of the laboratory meet the minimum construction requirements of NFPA 45, *Standard on Fire Protection for Laboratories using Chemicals*[78] for a Class C (low fire hazard) laboratory or a Class D (minimal fire hazard) laboratory. According to the expected chemical inventory, the quantities of flammable and combustible liquids and gases are within the limitations established by NFPA 45 for a Class D laboratory. Therefore, the laboratory is classified as a Class D laboratory (minimal fire hazard), in accordance with Section 4.2 of NFPA 45[78]. A laboratory unit is not limited in size according to Table 5.1.1 of NFPA 45[78]. The entire laboratory is considered one laboratory unit.

This Class D laboratory is classified as a Special Purpose Industrial Occupancy in accordance with ANSI/NFPA 101[24]. The life safety requirements for each laboratory room meet the most stringent code requirement. Each laboratory room is greater than 1,000 ft^2 and has a second means of access to an exit, as required for laboratory units by Section 5.4 of NFPA 45[78]. Also, chemical quantities are below the threshold for the Group H-3 IBC-2003[21] Occupancy, so the area is permitted to remain under the Group H-4 classification the same as the rest of the CPA.

According to Section 6.2.1 of NFPA 45[78], the minimum sprinkler density for a Class C or D laboratory is Ordinary Hazard, Group 1. However, the sprinkler system in this laboratory exceeds the minimum requirements for Class D and is protected throughout by a wet-pipe sprinkler system, designed, and installed as an Ordinary Hazard, Group 2 system, meeting the requirements of a Class A or B laboratory. The Hot Cell will be protected using extended coverage sidewall sprinklers and removable piping that penetrate the cell wall through sleeves. Sprinklers subject to mechanical damage are provided with listed guards to minimize the chance of inadvertent sprinkler discharge.

As a sprinklered Class D laboratory, this laboratory is permitted to have up to 75 gallons of flammable and combustible liquids and gases, excluding quantities in storage cabinets according to Table 10.1.1 of NFPA 45[78]. The Laboratory is permitted to have a total of 150 gallons of flammable and combustible liquids and gases, including quantities in storage cabinets according to Table 10.1.1 of NFPA 45[78]. Any flammable and combustible liquids will be stored in UL-listed storage cabinets for that purpose.

The Laboratory Bottle Storage Room (312A) will store other flammable and non-flammable compressed gases as necessary within the laboratory unit. The quantity of these gases will not exceed the NFPA 45[78] limit for the laboratory unit. As a DID measure, NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*[79] was used for the storage arrangement, separation distances of gas cylinder hazards and aggregate quantity limits of cylinders as necessary.

On the south side of the Hot Laboratory are Manipulator Decon and Repair rooms to perform maintenance on manipulators used in the Hot Cells. The manipulators operate with servo-motors, so there is no hydraulic fluid.

Drainage from a sprinkler discharge or safety shower will be through the floor drains near the bottom of Stair 3 and at the bottom of Stair 4. This meets the intent of NFPA 801[38] by preventing a potentially contaminated sprinkler discharge from escaping to the environment. Likewise, the discharge from a safety shower in the Laboratory will be captured by the drains at the bottom of the stairwells. Drains in the hot cell and gloveboxes drain to Lab Drain Tank (TK-235) located in the ASDT Process Cell. Drains in the hoods drain to the Lab Collection Tank (TK-236) in AFF.

Compressed flammable gases will be used in the Analytical Laboratory. Up to two 20-pound capacity (4.6-gallon capacity) propane tanks may be used to supply Bunsen burners in the Organic and Inorganic Laboratory areas. These tanks will be located under Laboratory benches with the discharge to the gas burner inside a hood. Bulk quantities will not be stored in the Laboratory. This amount of propane is below the maximum allowable quantity limitations of Section 11.1.6.7 of NFPA 45[78], for compressed and liquefied gases in cylinders. This section of NFPA 45[78] references Table 6.3.1.1 of NFPA 55[79], which permits 150 pounds of liquefied flammable gas for the Class D laboratory unit. Table 307.7(1) of IBC-2003[21] limits Class IB and IC flammable gases to 120 lbs in storage. The two 20-pound cylinders in the laboratory meet these requirements. There is currently no propane used in the laboratory. Plans are to use only one propane tank in the laboratory. Before propane is brought into the laboratory, a procedure will be prepared for its use. Annex F of NFPA 45[78] provides “Safety Tips for Compressed Gas Users,” which will be reviewed for this laboratory procedure.

Up to 5 lbs. of Class 2 Water Reactive material is permitted to be stored or in use in the Analytical Laboratory per Table 307.7(1) of IBC-2003. Up to 2 lbs. of Pyrophoric material may be stored in the Analytical Laboratory. Table 307.7(1) of IBC-2003 limits the storage of pyrophoric material to 2 lbs. accounting for the 50% reduction for a third floor area per Table 414.2.2 of IBC-2003. The use of a Pyrophoric material in an open system (where the material may be exposed to the atmosphere) is not permitted by Table 307.7(1) of IBC-2003 based on the current Occupancy classification of SWPF. This is an open item that will be resolved before Operations begin.

Each glove box will be limited to a total of 100 milliliters of flammable or combustible liquids in stainless steel containers and small quantities of radioactive material being analyzed. These limits are consistent with laboratory procedures in place for gloveboxes in F-Area laboratories at SRS (WSRC-TS-95-18, *F Area Central Laboratory Facility, Buildings 772-F, 772-1F, and 772-4F*[80]), and meets the intent of AGS-G010-2011, *Standard of Practice for Glovebox Fire Protection*[81]. Samples will be introduced into the glove box in glass or plastic bottles. All containers will be kept closed and only opened to use the liquids inside. The 100 milliliter volume limit only applies to gloveboxes; this limit does not apply to radiohoods, fume hoods, and the hot cell.

Fire extinguishers are located in the area. DID is provided for the Laboratory by using an Ordinary Hazard, Group 2, sprinkler system rather than an Ordinary Hazard, Group 1, system. Fire suppression systems are installed in the gloveboxes and hoods. A separate system is provided for

the hoods and glove boxes in each laboratory section (Inorganic Laboratory, Organic Laboratory, and Radiochemistry Laboratory). These systems are equipped with pressure reducing stations to reduce the supply pressure from approximately 130 psi to 30 psi, and the sprinklers inside the hoods and glove boxes are low flow sprinklers (K=2.8 in the glove boxes and K=1.4 in the hoods) to reduce the quantity of water while obtaining the minimum sprinkler density of 0.2 gpm/sq ft.

A Chemical Mixing Study was developed in S-SAR-J-00002[4] to determine which chemicals posed the greatest threat when mixed with other chemicals in the Laboratory. A fire is not credible for the concentrations at which the aqueous solutions are used.

There are no electrical systems or appliances, with the exception of refrigerators used for storing solvents, within the Analytical Laboratory that have a hazardous classification in accordance with NFPA 70[61]. This determination was made based on the fact that small amounts of hydrogen are made during normal operation, but these gases will not accumulate to the point of flammability. This is discussed in detail in 00-700-14618[65] and 00-700-20200, *SWPF Electrical Classification of the Analytical Laboratory*[82]. The quantities of flammable and combustible liquids are included in the total allowable quantities throughout the laboratory inside and outside of flammable liquid storage cabinets and refrigerators. The refrigerators are classified as Class 1, Division 1 areas and are labeled as suitable for solvent storage. The refrigerators are not equivalent to a flammable storage cabinet, but keep liquids cooled below their flash point.

3.2.16 Fire Area 14 –Contactor Support Floor Chase, South Utility Chase, and West Utility Chase

This Fire Area consists of the Contactor Support Floor Chase and the South Utility Chase which are located north and east of the Contactor Cell at the 116-ft elevation. These two areas are in the same air space. Non-routine access to this area is from a small two-hour rated hatch door in the CSSX Contactor Drop Area. The area contains process piping, conduit and ductwork.

The West Utility Chase is located west of the dark cells and is not normally occupied. This area is accessible through a small two-hour rated hatch door in the wall from the Process Building Exhaust HEPA Filter Room at the 116-ft level north of the dark cells. It contains piping, conduit and ductwork.

The ventilation ductwork in these areas is not required to be fire wrapped (refer to calculation C-CLC-J-00010[49]). These areas are not provided with sprinkler protection (see SWPF-12-021, *SRS Manager Approval of SWPF Fire Protection Equivalency, F-ESR-J-00005, R0*[83]).

3.2.17 Fire Area 15 – East CSSX Tank Cell

The East CSSX Tank Cell is designed so that access is not required over the life of the plant; however, an access hatch is provided at the 124-0-ft level for access into the cell, should an unplanned event occur.

The East CSSX Tank Cell contains the higher-activity tanks and the West CSSX Tank Cell contains tanks of lower activity. The cells are constructed with reinforced concrete floors and walls and stainless steel liners.

The head of the Strip Effluent Coalescer is accessible from the West CSSX Tank Cell through the two-hour fire barrier wall between the two CSSX Tank Cells. Access to the coalescer is from the CSSX P&VG through an airlock to the West CSSX Tank Cell.

The east and west sides of the CSSX Tank Cell each have a designated sump and level instrumentation. The CSSX sumps normally contain process water to provide a liquid seal for the Process Vessel overflows. The sumps are evacuated by the CSSX Tank Cell Sump Transfer Pump to the Solvent Drain Tank (TK-208) and an overflow to the Solvent Drain Tank (TK-208) is provided.

The concrete Cell floor is provided with a stainless steel liner that extends above the cell floor to provide liquid retention for the inventory of all aqueous wastes and solvent in the CSSX process equipment and tanks in this Cell. With the exception of the Strip Effluent Coalescer, no equipment in the East CSSX Tank Cell requires periodic maintenance and no corrective maintenance of equipment in this cell is anticipated. The East CSSX Tank Cell is equipped with ports to insert CCTV cameras to allow remote monitoring of Cell conditions when necessary.

Similar to the Process Cell vessels, the East CSSX Tank Cell vessels have the potential for an accumulation of H_2 gas or other flammable vapors from organics contained in the wastes. Refer to Section 3.2.4.3 for this discussion.

The electrical systems within the East CSSX Tank Cell area are not classified in accordance with NFPA 70[61]. This determination was made based on the fact that small amounts of hydrogen are made during normal operation, but these gases will not accumulate to the point of flammability. This is discussed in detail in 00-700-14618[65].

A spill of solvent or strip effluent could result from a breach in the cell process piping. Even if the entire cell sump volume below the overflow were filled with the worst case waste, the time for the cell to reach flammable conditions (assuming no dilution from the ADS, PVVS, or PBVS) would be longer than one year (see 00-700-14618[65]). Accounting for the breathing effects of diurnal atmospheric pressure changes results in an equilibrium hydrogen concentration of 39% of Lower Flammability Limit. Thus, a cell explosion is not considered credible for this area.

Another potential hazard associated with solvent extraction is a “red oil” explosion. Refer to Section 3.2.4.3 for this discussion.

The Cs-7SB modifier in the solvent mixture constitutes approximately 30% by weight of the total solvent mixture. The CSSX solvent fire byproducts were observed in combustion tests reported in WSRC-TR-2006-00171[70]. For an oxygen-deficient burn, no HF was detected in the by-products, indicating the fluoro hydrocarbon, Cs-7SB, does not burn. The modifier appeared to simply concentrate during the fire. It was not clear if the lack of oxygen inhibited the modifier from burning.

The ventilation ductwork in these areas is not required to be fire wrapped (see calculation C-CLC-J-00010[49]). There is no sprinkler system in the East CSSX Tank Cell (see SWPF-12-021[83]).

3.2.18 Fire Area 16 – HVAC Shielding Chase

The HVAC Shielding Chase is located between the dark cells and the building exhaust HEPA filter room and the exhaust fan room. This area contains steel ductwork, ventilation piping, and drain lines from ventilation equipment (e.g., PVVS and PMVS coolers and demisters). The room is sealed. Access to this room will only be possible if the opening used during construction is dismantled. The ventilation ductwork in these areas is not required to be fire wrapped (refer to calculation C-CLC-J-00010[49]). There are no sprinklers or drains in this room (see SWPF-12-021[83]).

3.2.19 Administration Building

The Administration Building is a single-story building. The structure is pre-engineered steel frame building with horizontal insulated metal panel exterior, a glazed window system, and an elastomeric roof over rigid insulation. The building was erected on a concrete slab foundation. Exterior openings consist of aluminum doors with insulated glass windows. The interior walls are gypsum wallboard over metal studs.

The building is rectangular in shape, 92’-6” x 152’-6” (see RCN-30070-SDC-061[17]). The total area of the building is approximately 14,106 ft^2. The building contains the following spaces: office areas, restrooms, lunchroom, electrical/telephone/data room, reproduction room, storage areas, janitor room, simulator room, and conference rooms.

This building is non-combustible construction with no fire-resistance rating. The type of construction is classified as Type II-B in accordance with the IBC-2003[21] and a Type II (000) in accordance with NFPA 220[23]. There are one-hour gypsum board walls around the Records Storage and Document Control Rooms, but there are no required fire-rated barriers in the Administration Building; therefore, the entire building is considered one Fire Area. The Administration Building design includes the use of insulated steel panels for the siding on the outside walls of the steel structure building. See the discussion above about this type of wall panels. The building is classified as a New Business Occupancy, in accordance with NFPA 101[24]. The classification of the hazard of contents is “ordinary hazard”. The calculated occupant load for the building is 145 persons, in accordance with Table 7.3.1.2 and Chapter 38 of NFPA 101[24].

The Administration Building is protected throughout by an Ordinary Hazard, Group 2, automatic wet-pipe sprinkler system. A fire alarm system is also provided for the facility. The alarm system consists of a fire alarm panel that reports to the Central Alarm Station, flow and tamper switches connected to the sprinkler system, manual pull stations provided at each exterior exit, a smoke detector in the electrical room and a duct smoke detector in the supply and the return ducts of the HVAC system. Alarm/strobe appliances are located throughout the facility, in accordance with NFPA 72[42]. Smoke detectors and duct smoke detectors are addressable devices under constant monitoring by the fire alarm control panel.

The Administration Building houses Administrative and Support personnel. This occupancy is Business (office space). The Administration Building contains office spaces, conference rooms, and training spaces, which will include a control room simulation room.

There are two direct exits from the building, located on the northwest and southeast corners of the building. The exit capacity is adequate for the calculated occupant load of 145 persons. This is the limiting number of occupants for the building. The exits are separated by greater than one-third of the building's diagonal dimension, as required for a sprinklered facility. The exits are arranged such that the maximum travel distance to an exterior exit is approximately 100 ft, which is much less than the 300-ft maximum allowed for a sprinklered building. The common path of travel for the building is within the 100-ft requirement for sprinklered Business Occupancy. NFPA 101[24] also requires that there be no dead ends in excess of 50 ft for sprinklered buildings. The Administration Building has no dead ends.

3.2.20 Compressor Building

The Compressor Building is a single-story pre-engineered structure. The exterior wall and roof construction consists of insulated metal panels over a structural steel roof framing system erected on a concrete floor slab. Wall openings on the north and south sides are provided with louvers and electrically actuated dampers. Roof-mounted exhaust fans are provided for ventilation. The building is approximately 31 x 75 ft and is provided with a rollup door and a personnel door. The total area of the building is approximately 2,300 ft^2. The building houses the PA compressors, Motor Control Centers, filters, coolers, dryers, and associated equipment.

The building is classified as Type II (000) construction, in accordance with NFPA 220[23] and the entire building is considered one Fire Area. For exiting and life safety requirements, the Compressor Building is classified as a Special Purpose Industrial Occupancy, in accordance with NFPA 101[24]. This building is classified as Type IIB construction by Table 601 of the IBC-2003[21] and is a Factory Industrial, Low Hazard, F-2, occupancy per Section 306.3 of the IBC-2003[21]. The classification of the hazard of contents is "ordinary hazard". The building is normally unoccupied except during maintenance and inspection activities. It is estimated that the maximum probable occupancy during these periods will be about five persons.

The Compressor Building is protected by an Ordinary Hazard, Group 2, wet-pipe sprinkler system. A fire alarm system is also provided for the building, consisting of a fire alarm panel that reports to the Main Fire Alarm Control Panel in the Process Building, flow and tamper switches connected to the sprinkler system, a heat detector above the fire alarm panel and a manual pull station provided at the exit. Horn strobe notification appliances are located in the building in accordance with NFPA 72[42].

There is one exit from the building, located at the southwest corner of the building. This exit arrangement results in a maximum travel distance and common path of travel of approximately 80 ft, which is less than the 400-ft maximum travel distance and the 100-ft common path of travel requirement of NFPA 101[24] for a sprinklered, ordinary hazard special purpose industrial

occupancy. The Compressor Building has no dead-end corridors. The exit arrangement is adequate for the building.

3.2.21 Next Generation Solvent Building

Note: The Next Generation Solvent (NGS) process will not be online at the time SWPF is brought online. The NGS process is not analyzed at this time. NGS building is analyzed as an exposure structure.

The NGS Building is a single-story steel-frame structure. The exterior wall and roof construction consists of insulated metal panels over a structural steel roof framing system erected on a concrete floor slab. A wall opening on the south side is provided with a louver and electrically actuated dampers. Roof-mounted exhaust fans are provided for ventilation. The building is approximately 60 x 60 ft and is provided with a rollup door on the east side and two personnel doors (one on the east side and one on the west side). The total area of the building is approximately 3,600 ft^2. The building houses tanks and pumps for the NGS process.

The building is classified as Type II (000) construction, in accordance with NFPA 220[23] and Type IIB construction by Table 601 of the IBC-2003[21]. For exiting and life safety requirements, the NGS Building could be classified as a Special Purpose Industrial Occupancy since its intended function will not change and its occupancy will remain very low. However, for conservatism, the egress for NGS uses the calculated occupant load for a General Industrial Occupancy in accordance with NFPA 101[24]. This is consistent with the architectural report A-RPT-J-00002, *International Building Code and NFPA 101 Life Safety Code Review*[84], and with the preliminary fire hazards analysis (in DCN-7006). This building is classified as a Factory Industrial, Low Hazard, F-2, occupancy per Section 306.3 of the IBC-2003[21]. The classification of the hazard of contents is "ordinary hazard".

The building is normally unoccupied except during maintenance and inspection activities. It is estimated that the maximum probable occupancy during these periods will be about five persons. The building is one Fire Area.

The NGS Building will be protected by an Ordinary Hazard, Group 2, wet pipe sprinkler system. A fire alarm system is also provided for the building, consisting of a fire alarm panel that reports to the Main FACP in the Process Building. Initiating devices consist of flow and tamper switches connected to the sprinkler system, a heat detector above the fire alarm panel, and manual pull stations provided at each exit. Horn strobe notification appliances are located in the building in accordance with NFPA 72[42].

There are two exits from the building, one on the east side and one on the west side of the building. This exit arrangement results in a common path of travel of approximately 60 ft and a maximum travel distance of approximately 100 ft, which is less than the 100-ft common path of travel distance and the 400-ft maximum travel requirement of NFPA 101[24] for a sprinklered, ordinary hazard industrial occupancy. The NGS Building has no dead-end corridors. The exit arrangement is adequate for the building.

3.2.22 Diesel Generator

The DG is an Industrial Occupancy enclosure in accordance with NFPA 101[24]. At least one portable fire extinguisher is located at the structure. There are no additional requirements for this structure. The DG Unit must meet the provisions of NFPA 110[16]. The standby DG is required by Specification 16231, *Standby Diesel Generator*[85], to operate at 100% capacity within 10 seconds. The main tank is required to contain enough fuel to operate the DG for approximately four days as stated in the Design Basis, P-DB-J-00004[22]. However, the DG is not Safety-Related. This DG is a Class X, Type 10, Level 2 Emergency Power Supply System, in accordance with NFPA 110[16]. A Level 1 Emergency Power Supply System (for life safety purposes) is not required for this project.

3.2.23 Temporary Tank Farm

The TTF was built to house six steel epoxy lined portable tanks (19,700 gallons each). The liquids simulate the process liquids during Commissioning (Cold Operational Testing), which are non-flammable, non-combustible liquids. The structure is approximately 60 ft by 96 ft (5,760 ft^2) and is 25 ft high. The structure sits on a concrete pad and is open on all four sides. It has a metal roof with siding that extends down from the roof on each side approximately 5 ft.

The liquids are mostly non-hazardous, but the quantities of liquids with a high pH exceeds 500 gallons (or 5000 lb), which is considered corrosive. As a result the TTF is an Open Structure with a Hazardous, H-4 (Health), Occupancy according to the IBC and a Special Purpose Industrial Occupancy according to NFPA 101. The structure is non-combustible, non-rated Type IIB construction. There are few fire hazards at the TTF. The combustible loads and ignition sources are the pumps that move liquids from TTF to CCA and elsewhere in the SWPF Process Building.

The TTF is not normally occupied. Personnel enter the TTF to load dry chemicals into the liquid mixtures in the portable tanks using an enclosed hopper. There are four portable fire extinguishers under the TTF roof – one on each side of the structure. Since the structure is open, egress is unlimited at TTF. Fire hydrant FH-28 is located 165 ft to the north, and hydrant FH-29 is located 65 ft to the south. According to Appendix B of the IFC, the required fire hydrant flow for a non-sprinklered structure up to 5,900 ft^2 of Type IIB construction is 1500 gpm for two hours, or 180,000 gallons.

The TTF is a temporary structure and not a permanent building. The replacement value is less than $3 million. The structure is deemed to be a low hazard structure with low combustibles and few ignition sources. The portable tanks will be removed at the end of Commissioning.

The TTF is over 80 ft from the Compressor Building and over 80 ft from the Loading Dock attached to the CCA. The TTF is 10 ft from a fabric tent that is in compliance with NFPA 102 (2016 edition), *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*[86]. The tent houses a breakroom for about 50 construction personnel in 1/3 of the tent. There are two means of egress from the tent, and the TTF does not interfere with egress from the tent. The remainder of the tent is empty.

3.3 Water Supply and Manual Attack

3.3.1 Water Supply Analysis

The J-Area SWPF Fire Protection Water System is supplied by two connections to the existing underground S-Area Fire Protection System. Eight-inch underground piping extend from the S Area system to form a loop around the entire J-Area site. The eight-inch loop supplies area fire hydrants and feeds six-inch lines that enter the SWPF Process Building at the east and west ends. This dual-fed loop provides a DID measure that helps the facility achieve an HPR status. Additional feeds from the SWPF loop provide the fire protection water supply to the Administration Building and Compressor Building. A feed from the loop supplies the NGS Building.

The J-Area water supply is provided by two automatically starting fire pumps, one electric and one diesel, located in S-Area. The rating of each pump is 2,000-gpm at 120 psi. The pumps take suction from a tank, reserving 240,000 gallons for fire protection. The pumps were replaced in 2015 to restore the water supply capacity to its original rating. A back-up water supply is available from H-Area by opening Post Indicator Valve No. 40. The fire pumps alarm at the SRSOC and the 210-S Control Room.

The 2015 Water Supply Testing showed that the S-Area Fire Pumps could supply adequate flow and pressure to satisfy all sprinkler and hose demands at the J-Area Warehouse. The 2016 Water Supply Testing determined that the H-Area Fire Pumps could provide an even greater pressure at the required flow demands when the cross-connect valve is opened. Routine testing of hydrants in J-Area provides assurance that the S-Area Fire Pumps and underground supply piping remain acceptable.

To alleviate pressure surges from the S Area water supply, bladder tanks were installed at the lead-ins to the SWPF Process Building, the Compressor Building, and at the NGS Building. There have been no inadvertent system trips since the surge tanks were installed.

The SWPF design utilizes an eight-inch loop with six-inch dead-end feeds to hydrants that are minimal in length. Additionally, there are no suppression systems designed for SWPF that place additional demands on the system in excess of the existing systems installed for the 221-S Vitrification Building, which is approximately the same elevation. The anticipated demand for fire hydrants at SWPF is 1,000 gpm, with minimum residual pressure of 20 psi. The water supply for SWPF is fully adequate and complies with applicable codes and standards.

Fire hydrants are located throughout J-Area, in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*[87]. All buildings are accessible with less than 300 ft of fire hose, Fire Department connections are located within 100 ft of a fire hydrant, and the system is segregated with isolation valves to prevent single-point failure issues.

The sprinkler system demand is based on NFPA 13[26], Ordinary Hazard, Group 2, occupancy classification requirements, resulting in a sprinkler density of 0.20 gpm/ft^2 over the hydraulically most remote 1,500 ft^2. Each sprinkler system is less than the maximum of 52,000 ft^2 of floor area

in accordance with NFPA 13[26]. Each system is equipped with a flow switch connected to the fire alarm panel. Each sprinkler system is calculated to determine the minimum demand required of the water supply. Section 7.2 of DOE-STD-1066-99[15] requires hydraulically designed sprinkler systems be designed for the demand curve 10% or 10 psi below the supply curve. The contractor shop drawings and calculations show that the water supply is greater than the demand for each system by a minimum of 10 psi.

The sprinkler systems were designed based on flow testing performed in 2011 at the top of the SWPF underground loop that indicated the available water supply has a static pressure of 145 psi (pump churn pressure with one pump operating) and a flow and residual pressure of 1,007 gpm at 120 psi at the north side (top) of the SWPF loop. As previously stated, S Area has made pump upgrades and performed more recent flow testing as part of their normal maintenance.

The largest sprinkler system pressure demand for the SWPF Facility is at the 139 Level Operating Deck at approximately 333 gpm at 104 psi plus 500 gpm for a hose stream allowance for a total requirement of 833 gpm at 104 psi (see RCN-30122-SDC-050, *0789-S11-01: Hydraulic Calculations System 11*[88]). The largest sprinkler system flow demand for the SWPF is at the 124 level Contactor system at approximately 928 gpm at 86 psi plus 500 gpm for a hose stream allowance for a total requirement of 1,428 gpm at 86 psi (see RCN-30122-SDC-067, *0789-S8-02: Hydraulic Calculations System 8*[89]*)*. The 500 gpm of hose stream in the calculations is added at nearby hose connections on the standpipe system inside the building instead of at the base of the riser or at a hydrant outside the building.

The sprinkler demand for the J-Area Warehouse is 1,200 gpm at 101 psi for the sprinklers and an additional 500 gpm for a hose stream allowance. This is a total requirement of 1,700 gpm at 101 psi. This sprinkler demand is supported by flow testing performed by DOE near the J-Area Warehouse that indicated the available water supply has a static pressure of 150 psi with pumps operating and a flow and residual pressure of 1,286 gpm at 130 psi. This is analyzed in the J-Area Warehouse FHA (see F-FHA-J-00002[5]*)*. The Vendor Data for the Warehouse can be found in the Construction, Shared Documents database.

3.3.2 Manual Attack and Emergency Response

The SRS Fire Department has three fire stations onsite. Each station and the equipment available, described in the Baseline Needs Assessment (BNA) document (F-TRT-G-00010, *Fire Department Emergency Response Baseline Needs Assessment*[90]), provides estimated Fire Department intervention times for each area at SRS. The response time to SWPF (J-Area) is approximately seven and a half minutes. This is considered adequate for this analysis. Response time is the sum of travel time plus 80 seconds (maximum turn-out time). Station 709-7G is the primary station and Station 717-11A is the secondary station responding to J-Area. Accessibility to the SWPF is good from the S-Area entrance or from the F Road entrance to SWPF. SRS fire fighters receive training, as documented in the BNA (F-TRT-G-00010[90]).

Based on the above, the Fire Department response is expected to be adequate. The Fire Department maintains a Fire Control Pre-plan for major facilities within SRS, which provides necessary

information that would be utilized in fighting a fire. The Fire Department updates the Fire Control Pre-plans for SWPF. The Pre-plans will be updated throughout commissioning and operations.

The SRS Fire Department has developed Fire Pre-plans for SWPF. The Fire Department BNA currently notes that SWPF is in a Pre-Operational Phase. Prior to Operations, the BNA and the Fire Pre-Plans will be revised by SRS to reflect radiological hazards as appropriate. The BNA will also identify the general emergency response requirements for fire-fighting forces and equipment response to fire emergencies at the SWPF. The addition of SWPF Operational Phase to the SRS BNA is an Operations Open Item (Open Item #1).

SWPF follows PP-OP-8509, *J-Area Emergency Response*[6], for fire and other emergencies. SWPF prepared Annex K for the Manual WSRC-SCD-7, *Savannah River Site Emergency Plan*[91]. This document identified emergency response measures that will be implemented to mitigate personnel injury, exposure to hazards, and property and environmental damage to the SWPF.

Section 9.3.1 of IBC-2003[21] requires this facility to be equipped with a Class III standpipe system since the highest floor level is more than 30 ft above the lowest level of fire department access. The Process Building and contiguous structures are provided with an interior standpipe hose system designed in accordance with Section 5.4.1.1 of NFPA 14[45], which permits a manual Class I standpipe in a non-high-rise building. A high-rise building is defined by Section 3.3.9 of NFPA 14[45] as a building where the top floor is above 75 ft. As a manual standpipe system, the typical standpipe calculation is not required. The system is a combination type that also serves as the supply to the automatic suppression systems. Hose connections are provided at each level of the stairwells and at selected strategic points throughout the facility. A single hose connection is located on the roof as required by Section 7.3.2 (5) of NFPA 14[45]. This hose connection is located at least 6 ft from the edge of the roof in accordance with 29 CFR 1926.502, *Fall protection systems criteria and practices*[92].

3.3.3 Administrative Controls

V-ESR-J-00012, *Emergency Response Interface Control Document [ICD-12]*[93], describes the interface between the SWPF Project and the Site Management and Operating Contractor's Emergency Response Organization (ERO) agreed to by the Memorandum of Agreement, SPD-SWPF-0196, *Salt Waste Processing Facility Project Memorandum of Agreement Regarding Interface Issues with Parsons Infrastructure & Technology Group Pertaining to the Salt Waste Processing Facility [SWPF] Design and Construction in J-Area*[94], which covers the operation of SWPF in J-Area. Other interfaces between the Site ERO and other Site emergency response organizations (including Site Fire Department, Emergency Spill Recovery Team, Site Medical Department, Information and Technology Division, and Site Security Services) are also described. V-ESR-J-00012[93] is a general agreement to provide emergency response, reporting, and coordination for emergencies that may occur at the SWPF during Commissioning/Operations activities. The emergencies addressed by V-ESR-J-00012[93] include occupational health and safety, environmental releases, security and safeguards breaches, transportation accidents, hazardous material spills, and fires.

V-ESR-J-00017, *Fire Protection Water System Interface Control Document (ICD-17)*[95], describes the interface between the Engineering, Procurement, and Construction (EPC) Contractor for SWPF and the Liquid Waste Operations (LWO) Contractor. As described above, the fire water supply for SWPF is provided from S Area. V-ESR-J-00017[95] describes the physical, programmatic, and administrative interfaces between the two organizations.

The BNA for the SWPF identifies emergency response facilities and the locations of all rally points and shelter locations where personnel may assemble during emergency conditions. Additionally, the Facility/Area Emergency Plan Implementing Procedures addresses the facility or area Emergency Personnel Accountability System.

S-SAR-J-00002[4] has identified the Fire Protection Program as Technical Safety Requirement Administrative Control 5.8.2.6 to minimize threats from fire. In particular, the Combustible Controls and Ignition Source Controls portions of the Program will be relied upon for fire prevention.

3.4 Life Safety Analysis

The Process Building is considered fully sprinklered since the Equivalencies, F-ESR-J-00002[56] and F-ESR-J-00005, *: Omission of Sprinklers in Waste Transfer Enclosure; West Utility Change; HVAC Shielding Chase; South Utility Chase and Contactor Support Floor Chase; and East CSSX Tank Cell* [96], have shown that an equivalent measure of protection is provided in unsprinklered areas. A fire alarm system is also provided for the facility. The fully addressable fire alarm system consists of a fire alarm control panel that reports to the Central Alarm Station, which is the Savannah River Site Operations Center. Input devices include manual pull stations provided at each exterior exit, flow and tamper switches connected to the sprinkler system, smoke detectors, duct smoke detectors, and heat detectors. Alarm horn/strobe notification appliances are located throughout occupied areas of the facility, in accordance with NFPA 72[42], as noted in Section 3.2.1.

The exhaust fan room (R202) and the adjacent rooms (R20201 and R203) do not meet the sound level requirements of NFPA 72[42] using the A-weighted decibel scale (dBA). However, these rooms meet the requirements of Narrow-band Tone Signaling requirements of NFPA 72[42] as shown in F-ESR-J-00007, *Analysis of Fire Alarm Horns in High Noise Areas*[97]. This document also shows how use of visible notification alone is permitted in the Compressor Building. Due to the high background noise. Other areas of the building do not meet the dBA requirements on occasion. These areas are continually monitored as conditions are constantly changing in the facility. Some areas may require additional horns while other areas may not. This is an Open Item. The Control Room has been designated a Private Mode area as permitted by NFPA 72[42] and industry practice. Horns in this area are permitted to be only 10 dBA above background rather than the standard 15 dBA above background.

Table 3-5 is a comparison of the LSC requirements (NFPA 101[24], the IBC-2003[21] requirements, and the actual properties of the building).

Table 3-5. Life Safety Requirements

	LSC (NFPA 101[24])	IBC-2003[21]	Actual
Building Construction Types (Note 1)	CPA: II(111) CCA: II(111) AFF: II(111) FSA: II(111) Admin. Bldg.: II(000) Comp. Bldg.: II(000)	CPA: II(A) CCA: II(A) AFF: II(A) FSA: II(A) Admin. Bldg.: II(B) Comp. Bldg.: II(B)	As defined
Building Occupancies	CPA: Spec. Purpose Industrial CCA: Spec. Purpose Industrial AFF: Spec. Purpose Industrial FSA: General Industrial Admin. Bldg.: Business Comp. Bldg.: General Industrial	CPA: Hazardous Gr. 4 (H-4) CCA: Hazardous Gr. 4 (H-4) AFF: Hazardous Gr. 4 (H-4) FSA: Fac.-Ind., F-2 (F2) Admin. Bldg.: Business (B) Comp. Bldg:Fac.-Ind., F-2 (F2)	As defined
Hazard of Contents	Ordinary	NA	Ordinary
Occupant Load (entire facility)	75	301 (Calculated for egress design only)	75
Dead End Corridor	50 ft	20 ft (1016.3)	0 ft
Common Path of Travel	100 ft	CCA, CPA, AFF: 75 ft (1013.3) FSA: 100 ft (1013.3)	120 ft (Note 2)
Travel Distance to Exit (with sprinklers)	Business: 300 ft General Industrial: 250 ft Spec. Purp. Industrial: 400 ft	B: 300 ft (1015.1) F-2: 400 ft (1015.1) H-4: 175 ft (1015.1)	Less than 175 ft.

Notes:
1. NFPA 220[23]
2. Equivalency F-ESR-J-00001 (*SWPF Fire Protection Engineering Equivalency Request Process Building Contactor Operating Deck Common Path of Travel*[98]) permitted excessive Common Path of Travel.

3.4.1 Occupancy

The CPA is classified as a Special Purpose Industrial Occupancy, in accordance with Chapter 40 of NFPA 101[24], and a Group H-4 Occupancy in accordance with Section 307 of IBC-2003[21]. The building is characterized by a relatively low density of personnel, with much of the area occupied by process and maintenance equipment. This building is further classified as a limited-access structure, in accordance with Chapter 11 of NFPA 101[24].

In addition, the classification of the hazard of contents is "ordinary hazard", in accordance with NFPA 101[24]. This classification is based on the relative danger of the start and spread of fire, danger of smoke and gases generated, and danger of a potential explosion.

3.4.2 Occupant Load

The occupant load is used to calculate the maximum possible occupants in the building, determine adequate emergency egress components, and establish the capacity of the exits. According to Section 1004 of IBC-2003[21], the actual occupant load can be used for individual spaces (i.e., an Assembly room in another occupancy), but the calculated occupant load shall be used for the egress design. As stated in the *Commentary* for Table 1004.1.2 of IBC-2003[21], because the specific type of facility is not listed in the table, the occupancy it most closely resembles should be used. The occupancy the SWPF most closely resembles for personnel is a warehouse. There will be very few people in the building, compared to a typical industrial facility. The only hazardous facility listed is for a semiconductor manufacturing facility. The occupant load factor is 500 ft^2 per person based on the special nature of the process in the building. Therefore, the calculated occupant load for the 116- and 139-ft levels is 65 people at each level. The occupant load for the 124-ft level is 9 people. The occupant load for the 100-ft level CPA, CCA, AFF, and FSA is 162 people. Thus, the total calculated occupant load for the building is 301 people. The expected occupant load is 75 people. In accordance with Table 7.3.1.2 and Chapter 40 of NFPA 101[24], for Special Purpose Industrial Occupancies, an occupancy load factor is not used. For this occupancy, the exit capacity is determined, based on the maximum expected number of personnel in the facilities. Small conference rooms and office spaces are considered incidental to the building occupancy, as allowed by NFPA 101[24]. The number of building occupants for the SWPF Process Building is expected to be less than the calculated load.

3.4.3 Means of Egress

The Process Building provides seven general building exits to the exterior. Section 1019.1 of IBC-2003[21] requires one-hour vertical exit enclosures (stairwells) connecting less than four stories. However, to maintain the two-hour barrier separation defined by DOE, the stairwells are two-hour-rated enclosures. According to Table 601 of IBC-2003[21], floors of Type II-A construction are required to be one hour rated. However, floors in SWPF are two hour rated to separate the fire areas on different floors. This additional protection also creates a separate exit. A horizontal exit is defined by Section 1021.2 of IBC-2003[21] as a minimum two-hour fire barrier wall with no unprotected openings. When traveling down Stairway #3 and discharging to the first floor, the occupant is in a separate fire area, which is the same protection provided as a horizontal exit. There are three separate exits from the upper floors provided by fire-rated stairwells: two on the west side of the building (Stairways # 1 and #4) and one at the northeast corner of the CPA (Stairway #2), which exits through the main building entrance on the north side of the building. Although Stairway #3 is not a required means of egress, it could be used as an additional exit if needed.

The stair treads are permitted to have openings according to Section 7.2.2.3.3.4 (3) of NFPA 101[24] for Industrial Occupancies and according to the Exception to Section 109.5.1 of IBC-2003[21] for H Occupancies.

The west stair enclosures, Stairwells No. 1 and 4, or a minimum 50% of the required means of egress, discharge directly to the exterior of the building as required by Section 1023, Exception #1 of IBC-2003[21] and by Section 7.7.2 of NFPA 101[24]. The door from the first floor into Stairwell

No. 4 does not allow re-entry back into the building. Each stairwell serves three floors. Stairwell #1 serves floors at levels 116 ft and 139 ft. Stairwell #4 serves floors at levels 100 ft, 124 ft, and 139 ft. For stairwells serving four or more stories, re-entry back into the building is required by Section 7.2.1.5.7 of NFPA 101[24]. The code does not permit nor prohibit re-entry for stairwells serving less than four stories. The door on the first floor of Stairwell #4, which does not permit re-entry, meets the criteria of Section 7.2.1.5.7.1 of NFPA 101[24] since other specific re-entry doors are available in the stairwell and the doors are noted as such in the stairwell.

The northeast stair, Stairwell No. 2, discharges into a two-hour protected corridor (or tunnel) on the ground level of the building. Section 7.7.2 of NFPA 101[24], permits this stairwell to discharge into a corridor on a floor that is separated from other non-sprinklered floors and areas of the building by two-hour-rated barriers and the floor of discharge must be sprinklered. Also, the way to the exterior of the building must be "readily visible and identifiable" from the point of discharge from the exit. Exception #1 to Section 1023.1 of IBC-2003[21] permits this stairwell to discharge into a corridor on a floor where the corridor is protected from areas below with the same rating as the exit enclosure, the egress path is protected by an automatic sprinkler system, and the egress path is "readily visible and identifiable" from the termination of the exit enclosure to the exterior of the building. The building meets this requirement by the use of doors in the corridor and exit signs directing occupants to the outside.

In addition, the HVAC supply diffusers in this exit discharge corridor contain fire rated dampers to isolate this means of egress. The corridor doors are held open by magnetic devices and the fire alarm system will automatically close the doors upon activation of the fire alarm system. This tunnel passes through an office suite. The doors to these offices are fire rated to maintain the rating of the tunnel. The door from the first floor Controlled Entry Area opens into the tunnel to maintain the direction of travel in the means of egress to the tunnel. The door from Stairwell #2 opens into the Controlled Entry Area on the first floor, but has a directional Exit sign pointing to the door that leads to the tunnel.

The corridors throughout the building are one-hour-rated, except for the two-hour discharge corridor noted above, as required by Table 1016.1 of IBC-2003[21], and by Section 7.1.3.1 of NFPA 101[24]. Fire dampers are permitted to be omitted from one-hour corridor walls according to Section 716.5.4, Exception 1 of IBC-2003[21] and by Section 5.3.1.1 of NFPA 90A[50]. Therefore, the ducts penetrating the one-hour corridor walls are not equipped with fire dampers. The 1 hour and 2 hour tunnels in Northern Facility Support Area are shaft wall designs with a UL Design number that allow for a stud as small as 2 ½-inch.

The 1-hour corridor at the 139 Level south of the Analytical Laboratory contains utilities that do not obstruct the required width of the means of egress as permitted by Section 1003.6 of IBC-2003[21] and Section 7.2.1.2 of NFPA 101[24]. The corridor at Level 139 is defined as an Exit Access Corridor. The discharge from Stairwell #2 to the outside is defined as an Exit Passageway or Exit Enclosure to the Exit Discharge. The stairs are not permitted to have utilities according to Section 1019.1 of IBC-2003[21] for vertical exit enclosures. Refer to the following definitions:

Definitions from Chapter 3 and 7 of NFPA 101[24] (Definitions are similar in the IBC):

4. **Exit**. That portion of a means of egress that is separated from all other spaces of a building or structure by construction or equipment as required to provide a protected way of travel to the exit discharge.
5. **Exit Access**. That portion of a means of egress that leads to an exit.
6. **Exit Access Corridors**. Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with 8.2.3.
7. **Exit Discharge**. That portion of a means of egress between the termination of an exit and a public way.
8. **Exit Enclosure**. An exit enclosure shall provide a continuous protected path of travel to an exit discharge.
9. **Exit Passageway** (defined in the Annex, A.7.2.6) as: "An exit passageway serves as a horizontal means of exit travel that is protected from fire in a manner similar to an enclosed interior exit stair. Where it is desired to offset exit stairs in a multistory building, an exit passageway can be used to preserve the continuity of the protected exit by connecting the bottom of one stair to the top of the stair that continues to the street floor. Probably the most important use of an exit passageway is to satisfy the requirement that at least 50% of the exit stairs discharge directly outside from multistory buildings (see 7.7.2). Thus, if it is impractical to locate the stair on an exterior wall, an exit passageway can be connected to the bottom of the stair to convey the occupants safely to an outside exit door. In buildings of extremely large area, such as shopping malls and some factories, the exit passageway can be used to advantage where the travel distance to reach an exit would otherwise be excessive."

Section 40.3.6 of NFPA 101[24] states "The provisions of 7.1.3.1 shall not apply." This means that the corridor at Level 139 is not required. However, it is prudent to have a 1-hour corridor from the Laboratories to the Stairwells.

Separate exterior exits are provided from the Truck Bay area and the central corridor. Additional direct exits to the exterior of the building are provided from the north corridor, from the equipment corridor on the east side, and from the CCA and AFF areas located on the ground level of the south section of the building. Multiple exits are separated by greater than one-third of the building diagonal, as required for a sprinklered facility. Based on 0.2 inches of egress width per person for level components and 0.3 inches per person for stairs, as required by Table 7.3.3.1 of NFPA 101[24], the capacity of the three exits is adequate for up to 540 persons, which is greater than the calculated occupant load of 301 persons, and much greater than the expected occupant load of approximately one fourth of the calculated load.

3.4.4 Illumination and Marking of Means of Egress

Illumination of means of egress and marking of means of egress has been provided where required in accordance with Sections 7.8 and 7.10 of NFPA 101[24], including the Administration Building, the Compressor Building and the NGS Building. Normal lighting for the means of egress meets the minimum of 10 ft-candles for stairs and 1 ft-candle for all other walking surfaces. As mentioned

above, self-luminous exit signs are installed in SWPF that meet the requirements of NFPA 101[24]. There is no specific inspection or testing requirement for self-luminous signs; however, the exit signs are checked on a monthly basis.

3.4.5 Emergency Lighting

Emergency lighting has been provided where required in accordance with Section 7.9 of NFPA 101[24], including the Administration Building, the Compressor Building and the NGS Building. Emergency lighting for the means of egress meets the initial average of 1 ft-candle for the means of egress with not less than 0.1 ft-candle at any point in the means of egress. After one and a half hours, the illumination did not decline to less than an average of 0.6 ft-candle for the means of egress with not less than 0.06 ft-candle at any point in the means of egress. These lights are tested monthly and annually in accordance with NFPA 101[24].

3.4.6 Maximum Travel Distances

Exits from the facility are arranged such that the maximum travel distance to an exterior exit, an exit enclosure, or a horizontal exit is 175 ft in the CPA, less than 175 ft in AFF, and less than 150 ft in CCA, which meet the requirements of IBC-2003[21] for a sprinklered building. A horizontal exit is defined by Section 1021.2 of IBC-2003[21] as a minimum two-hour fire barrier wall with no unprotected openings. A horizontal exit is equivalent to a public way when measuring the total travel distance. Travel distance ends when the occupant reaches the horizontal exit. However, adequate egress must be provided from the horizontal exit in the new area. Common path of travel is defined as the distance a building occupant must travel before two separate and distinct routes become available. The maximum common path of travel in the FSA is 100 ft for a sprinklered building, as permitted by Exception 1 to Section 1013.3 of IBC-2003[21]. Egress from the Contactor Operating Deck on the 124-ft elevation exceeds the maximum allowable common path of travel distance. The exit arrangement provided for the Contactor Operating Deck results in an approximately 120-ft common path of travel. Only one exit is provided for this room, and the distance that must be traversed before two separate exit paths are available exceeds the requirements of NFPA 101[24]. Equivalency Request F-ESR-J-00001[98] (see SWPF-07-252[64]) was approved by the Authority Having Jurisdiction for this exit arrangement.

As noted in the Equivalency, the Contactor Operating Deck is a normally unoccupied space. A Radiation Worker Permit and safety procedures will be in place after contactors are drained and radiological control personnel have determined that entry into the space may be allowed. Procedures will be carefully planned to perform the necessary work prior to entry. This will include the need to arrange the work to leave a clear path to the exit. Since this room will be a high radiation area, the planning will include as low as reasonably achievable (ALARA) concerns. During Operations, there will be a two person rule when entering the room, plus an additional person will act as a safety observer. To gain access to the room, the process operations would be shut down, and the contactors flushed and drained until the radiation conditions are acceptable.

Only the last four contactors in the room exceed the allowable Common Path of Travel. An Operations Open Item (OOIT-117) is open to create Administrative Controls for access to this

room. Access to the Contactor Operating Deck will be controlled by SOP-ENTRY-001, *Entry and Closure Control*[6], and is expected to occur less than 10 times per year. P-ESR-J-00003, *SWPF Operations Assessment and Tank Utilization Models*[99], estimates the Mean Time Between Failures as approximately one failure every 4.7 years.

A typical activity in the room will include replacement of a contactor. The actual maintenance work on the contactor would be done in a shop elsewhere. Only the four contactors in the back of the room, at the highest radiation area, are located in the area that exceeds the Common Path of Travel limit. Most entries into the room will be to work on contactors whose location does not exceed the Common Path of Travel. Thus, access to the last four contactors will average approximately once per year. This is considered non-routine and infrequent.

Operations may develop the ability to predict contactor failures. More than one contactor may be replaced at the same time, requiring fewer entries into the room. Also, noted in the Equivalency, the condition is considered acceptable based on the following features:

1. Automatic sprinkler protection provided throughout the means of egress from this area.
2. Occupant notification systems including horns and strobes located throughout the facility.
3. Ventilation control of smoke in the Fire Area and the Exit.
4. The limited fixed and transient combustible load in the Contactor Operating Deck.
5. The restricted access and infrequent occupancy of this area as indicated in the ALARA Design Review Report (S-EIP-J-00004, *SWPF Final Design ALARA Review Report*[100]).
6. Administrative controls for the preparation and identification of hazards prior to entry.
7. Occupants familiarity with the facility and sufficiently mobile to perform physical work.
8. The short travel distance to the Exit, which is only 15-ft more from the door to R252 to the door to Stairway #4.
9. Fire barrier separation between this Fire Area and other areas of the building.
10. Fire Barrier separation of the Exits from the building.

NFPA 101[24] also requires that there be no dead ends in excess of 50 ft for either sprinklered or unsprinklered buildings. The Process Building has no dead end corridors.

All exterior exit doors and exit access doors in the means of egress in the building operate from the egress side (inside) with a single obvious motion to open, as required by NFPA 101[24]. In some cases, interior doors swing from the corridor into a room, against the direction of travel; however, these doors serve areas with occupant loads less than 50 persons and are allowed by NFPA 101[24]. Provisions for life safety at the SWPF are adequate for its intended use for Special Purpose Industrial Occupancy, as defined by NFPA 101[24]. With the exception of the Contactor Operating Deck exit arrangement discussed above, there are no dead ends or excessive common paths of travel. Maximum travel distance is 225 ft. The arrangement and means of egress meet the intent

of NFPA 101[24], as there are continuous and unobstructed ways of exit travel from any occupied area of the facility.

3.4.7 General Provisions

Architectural drawings identify the portable fire extinguisher types and locations in the building. These design features were installed in accordance with the requirements of NFPA 10[41].

Surface finishes and coatings meet NFPA 101[24] and IBC-2003[21] for Northern Facility Support Area, Eastern Facility Support Area, and CCA. The CPA and AFF meet the surface finish requirements of NFPA 801[38]. Section 5.8 of NFPA 801[38] requires walls and ceilings of areas processing or storing radioactive material to have a Class A finish and floors to have a Class I finish.

3.5 Fire Exposure

The exposure hazards between buildings were evaluated, using NFPA 80A, *Recommended Practice for the Protection of Building from Exterior Fire Exposures*[101]. Exposure is a measure of the likelihood of the building igniting, due to radiant heat transfer from a fire in an adjacent exposing structure. The most significant structures located in the general vicinity of the SWPF Process Building are the Administration Building (located northeast of the Process Building), the NGS Building (located to the east) and the Compressor Building (located to the west). These steel-frame non-combustible buildings are provided with automatic sprinkler system protection. In accordance with NFPA 80A[101], where the exposing building or structure is protected throughout by an approved, properly maintained automatic sprinkler system of adequate design for the hazard involved, no exposure hazard exists.

Two 2,000- kilovolt-ampere (kVA) substation transformers are located south of the SWPF AFF. Two 2,000-kVA and two 3,000-kVA transformers are located north of the SWPF FSA. These liquid-insulated transformers each contain less than 5,000 gallons of UL Listed less flammable liquid, as defined by FM Property Loss Prevention Data Sheet 5-4 (*Transformers*[102]). The transformers are UL Listed (which also meets the requirements of an FM Approved transformer). Tables 2a and 2b of FM Data Sheet 5-4, indicates that these transformers may be located as close as 3 ft horizontal distance from the building and other transformers. These transformers meet the requirements of the FM Data Sheet 5-4 separation distance for exposure protection from the building and other transformers.

Six air-cooled chillers on concrete pads are also located approximately 30 ft north of the SWPF Process Building. These structures pose no exposure threat.

The DG switchgear and load bank are 29.7 ft north of the Compressor Building, and the DG is 51 ft north of the Compressor Building. The fuel tank is approximately 10 ft north of the DG. The DG is over 72 ft west of the SWPF Process Building, and the Compressor Building is 69 ft west of the SWPF Process Building. The Compressor Building is protected with automatic sprinklers.

The closest structure to the Compressor Building is the DG switchgear. This equipment has dimensions of 25 ft x 10 ft x 8.5 ft high. The surface facing the Compressor Building is 25 ft x 8.5 ft. According to Chapter 4 of NFPA 80A[101], the width/height = 2.94; the fire severity is moderate; and the percentage of openings is 50% since the Compressor Building is sprinklered. This results in a Guide Number of 2.26 from Table 4.3.7.3 of NFPA 80A[101]. The required separation distance is then 27.3 ft, which is less than the actual separation distance of 29.7 ft.

The Temporary Tank Farm (TTF) is located over 80 ft from the Compressor Building and over 80 ft from the Loading Dock attached to the CCA. The effective face of TTF to the Compressor Building and to the CCA Loading Dock is 96 ft by 25 ft high and has a width/height ratio of 3.84. The fire severity of TTF is light, and the percent openings is 100%. The NFPA 80A[101] Guide Number is 2.51. The required separation distance is 68 ft, which is less than the actual separation distance of over 80 ft.

Temporary trailers on site have been analyzed for exposure to other structures by the Site Permit process. All trailers are more than 100 feet from permanent buildings. Based on the above, the SWPF meets the applicable requirements of NFPA 80A[101] and FM Property Loss Prevention Data Sheet 5-4[102] regarding protection from fire exposures.

3.6 Natural Phenomenon Hazards Fire Impacts

3.6.1 Lightning

Using the methodology described in Annex L of NFPA 780, *Standard for the Installation of Lightning Protection Systems*[103], it was determined that the probable lightning strike frequency for the SWPF is such that a lightning protection system should be provided. Due to the non-combustible construction and occupancy characteristics of the facility, the primary concern of lightning strikes to SWPF will not be fire, but instead will be disruption of power/control systems. Lightning-induced electrical outages will not render fire systems inoperable.

A lightning protection system is installed at SWPF. This system consists of strike terminal devices or air terminals, grounding conductors, building grounding system, etc., in accordance with NFPA 780[103].

The lightning protection systems at SWPF were installed by a certified vendor. These systems received a UL Master Label Certificate of Inspection for Lightning Protection Systems in 2015 and are due for recertification in 2020.

Results of the NFPA 780[103] Assessment are as follows:

NFPA 780[103] – Annex L Lightning Risk Assessment				
L.5 Tolerable Lightning Frequency *(N_c)*				
N_c	=	$(1.5 \times 10^{-3})/C$		
		where $C = (C_2)\ (C_3)\ (C_4)\ (C_5)$		
C_2	=	1.0	Structural Coefficient from Table L.5(a) (nonmetallic structure and roof)	
C_3	=	1.0	Structure Contents from Table L.5(b) (standard value and nonflammable)	
C_4	=	1.0	Structure Occupancy from Table L.5(c) (normally occupied)	
C_5	=	5.0	Lightning Consequence from Table L.5(d) (continuity of facility services required, no environmental impact)	
C	=	5.0		
N_c	=	$(1.5 \times 10^{-3})/5$		
N_c	=	0.000300		
L.3 Lightning Strike Frequency *(N_d)*				
N_d	=	$(N_g)\ (A_e)\ (C_1)$		
		where:		
		N_d = yearly lightning strike frequency to the structure		
		N_g = yearly average strike density in the region		
		A_e = equivalent collective area of the structure		
		C_1 = environmental coefficient		
N_g	=	4	Lightning flashes/km/yr from Figure L.2	
A_e	=	$LW + 6H(L+W) + \pi 9H^2$		
		where:		
		L =	300	Building length (ft).
		W =	310	Building width (ft).
		H =	77	Building height (ft).
		π =	3.14	
A_e	=	542458.5254	ft^2	
A_e	=	0.050396046	km^2	
C_1	=	0.5	Environmental coefficient from Table L.4.3	
N_d	=	0.100792092		
The lightning strike frequency is greater than the tolerable lightning frequency. Therefore; a lightning protection system is required.				

3.6.2 Earthquakes

Two major earthquakes have occurred within 196 miles of SRS. The Charleston, South Carolina, earthquake of 1886 occurred approximately 90 miles from the SRS area and was characterized as having a magnitude of 7.5. The Union County, South Carolina, earthquake of 1913 had an estimated magnitude of 4.5 and occurred 90 to 100 miles from SRS. Earthquakes of lower magnitude have occurred in recent years.

The CPA is designed to PC-3 criteria. The FSA, CCA, and AFF are designated as PC-1. All PC-1 areas of the Process Building are designed to be seismically-isolated, preventing the PC-1 structural elements from adversely affecting the CPA during an NPH event. The fire barrier walls and floors inside the CPA are designed to withstand a seismic event, the fire barriers outside the CPA are not designed to withstand a seismic event. While the CPA structure is PC-3, the automatic

sprinkler systems in the CPA and elsewhere will meet PC-1 criteria. The PBVS and PVVS are designed to PC-1 requirements. These systems provide ventilation for the Process Cells, thereby limiting the concentration of H_2 and other combustible gases. Earthquake-induced electrical outages should not render fire systems inoperable, due to back-up power provisions. Operational control is planned for post-seismic recovery.

Seismic bracing for the sprinkler systems were designed in accordance with NFPA 13[26]. Use of the NFPA 13[26] method for seismic bracing design is conservative compared to G-ESR-J-0002, *SWPF Piping Systems Structural Integrity Acceptance Criteria*[104], which are based on DOE-STD-1020-2002[10] and DOE-STD-1021-93[9]. The simplified equations for PC-1 piping in G-ESR-J-0002[104] for static horizontal and vertical seismic forces are:

Horizontal Force, Fp = (0.227g) * (mass of piping system)
Vertical Force, Fpv = (0.10g) * (mass of piping system)

The equations from NFPA 13[26], Paragraphs 9.3.5.6 and 9.3.5.7 are:

Horizontal Force, Fp = (0.50g) * (mass of piping system)
Vertical Force, Fpv is not applicable since the horizontal seismic calculation load does not exceed 0.5g * (mass of piping system).

This is valid since the sprinkler system hangers are "designed to support five times the weight of the water-filled pipe plus 250 lb at each point of piping support" (see Section 9.1.1 of NFPA 13[26]), which is far more than the seismic requirement for the vertical force of 0.10g * (mass of piping system). The NFPA 13[26] requirements exceed the minimum requirements of the DOE Standards for seismic design.

Victaulic couplings have been used on the sprinkler piping throughout the facility. A specific Victaulic fitting that uses multiple Victaulic couplings for seismic movement has been used where the interior loop penetrates the CPA structure to save space. The fittings are UL Listed for more than the required movement of the structures.

3.6.3 Floods

A flood involving SWPF is not considered a credible event. The area designated as J-Area is located on a relatively elevated region of SRS, more than 100 ft above any flood plain.

The Federal Emergency Management Agency (FEMA) Flood Map Service Center website (shown below) shows the S- and J-Areas designated as an "area of minimal flood hazard" (https://msc.fema.gov/portal/search?AddressQuery=savannah%20river%20site#searchresultsanchor).

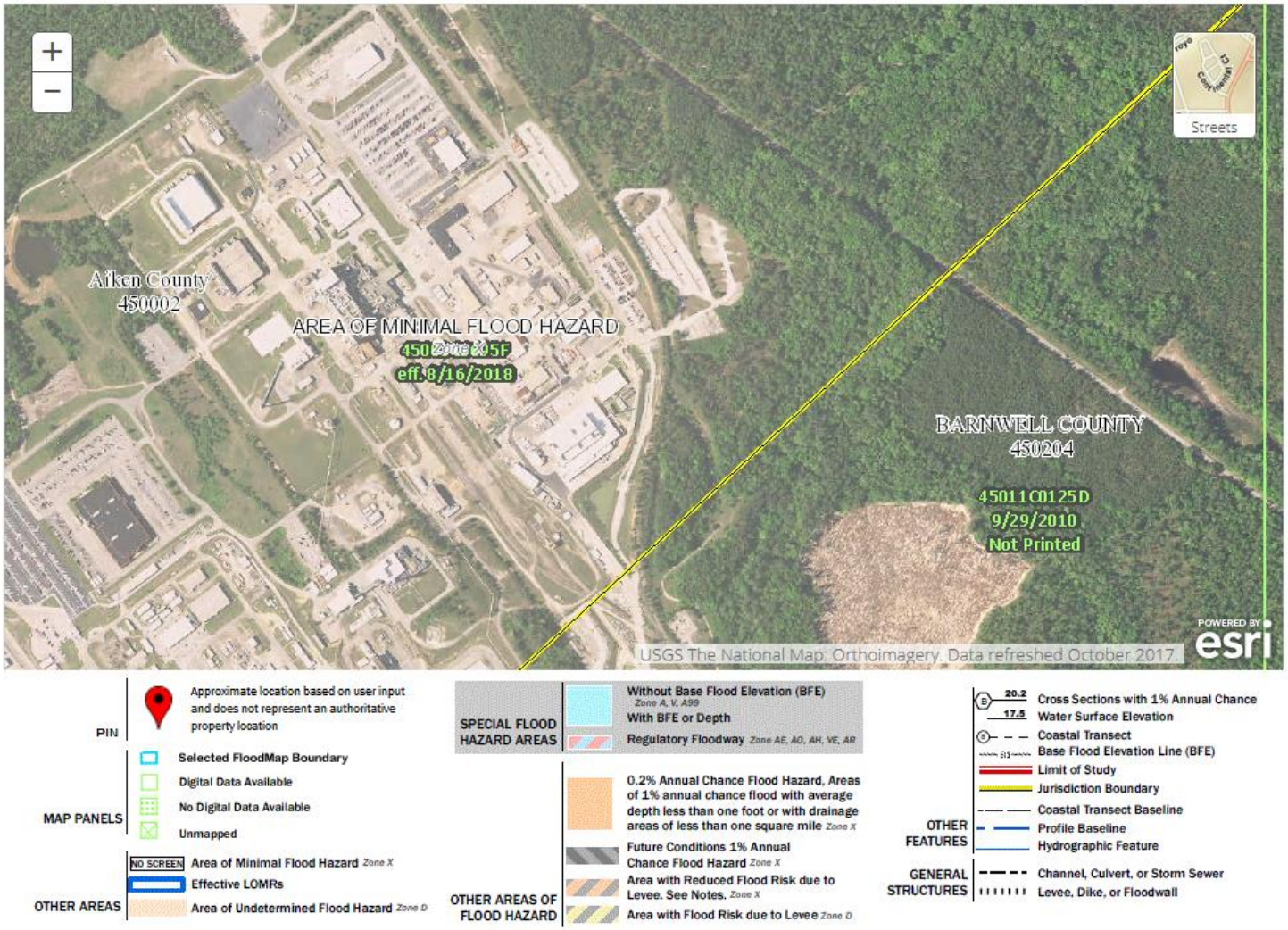


Figure 3-8 FEMA Flood Zone Map

3.6.4 Wildland Fire

The SRS is surrounded by woodland areas. The areas are well-managed full-time by the U.S. Forest Service to minimize the threat of wildland fire. In addition, the land around the facilities is cleared of trees to create a large buffer between the woodlands and the structures. This is managed by an Interagency agreement between the USDA Forest Service and the DOE Savannah River Site. The US Forrest Service produces an Annual Prescribed Fire Plan. This plan shows areas designated for prescribed fire burns. Also, the Fire Management Plan (FMP) 2018 is currently being developed. J-area is in the Fire Management Unit (FMU) considered the Industrial Core Management Area.

3.6.5 Other Hazards

The structural frame and exterior components of all buildings, tanks, towers, and other exposed structures are designed to resist pressures from design wind loads from any direction. Specifically, the CPA was designed for PC-3 wind speeds of 133 and 180 miles per hour for straight wind and tornadoes, respectively, in accordance with DOE-STD-1020-2002[10]. Other structures that are designated as PC-1 structures were designed to the loads required by the IBC-2003[21].

3.7 Fire Protection Program Analysis

3.7.1 Program Elements

DOE O 420.1B[1] was used for the design and construction of SWPF. Recently, the contract was modified to incorporate DOE O 420.1C, *Facility Safety*[105], for the operational aspects of SWPF. The Fire Protection Program has been developed by Fire Protection Engineering and implemented at SWPF. The plan, F-PP-J-00001, *Fire Protection Program Plan*[106], outlines the basic requirements of the Fire Protection Program:

- F-PP-J-00001[106]

Current staffing at SWPF includes a fire protection engineer in the Engineering Department, a fire protection engineer in Operations, a Cognizant System Engineer who is a qualified fire protection engineer, a Fire Protection Coordinator, and his back-up.

Fire Protection Engineering has developed upper level procedures outlining the basic requirements of the fire protection program. Procedures associated with the Fire Protection Program Plan include the following Project Procedures:

10. PP-EN-5036 *Fire Protection Impairment Control*[6]
11. PP-EN-5037 *Fire Prevention Inspections and Assessments*[6]
12. PP-EN-5038 *Flammable and Combustible Liquids and Gases*[6]
13. PP-EN-5043 *Combustible Load and Ignition Control Procedure*[6]
14. PP-EN-5048, *Evaluation and Resolution of Fire Protection Engineering Issues*[6]
15. PP-EN-5049, *Facility Fire Protection Assessments*[6]

16. PP-EN-5050, *Fire Protection Program Assessments*[6]
17. PL-EN-5024, *Fire Protection Management and Administration*[107]
18. PL-TR-1817, *Fire Protection Training Program Description*[108]

The Fire Protection Impairment Control procedure (PP-EN-5036) and form (SWPF-549) have been in use for over two years and are fully developed. The Fire Prevention, Inspections, and Assessments procedure (PP-EN-5037) and form (SWPF-658) have been in use for over two years and are now fully developed. In addition to the upper level procedure, the Computerized Maintenance Management System (CMMS) contains detailed steps for performing inspection and testing of the passive and active systems. The Flammable and Combustible Liquids and Gases procedure (PP-EN-5038) and form (SWPF-794) have been in use for over two years and are now fully developed.

The Combustible Load and Ignition Source control procedure (PP-EN-5043) and forms (SWPF-817, -818, and -819) have been in use for over one year and are now fully developed. This procedure is based on NFPA 13[26] criteria is consistent with F-TRT-A-00026, *Fire Protection Engineering Technical Report Building 773-A Combustible Storage*[109].

The following additional Project Procedures developed by other organizations are referenced in the fire protection procedures listed above to assist in the implementation of the Fire Protection Program:

- OPSINSP-SWPF-001 *J-Area Operations Inspection*[110]
- PL-AS-1001 *Integrated Assessment Program Plan*[111]
- PL-MN-8709 *Work Control Program Plan*[112]
- PL-TR-1802 *Operations Training Program Description*[113]
- PL-TR-1803 *Maintenance Training Program Description*[114]
- PL-TR-1805 *Cognizant System Engineer Training Program Description*[115]
- PL-TR-1813 *Engineering Technical Staff Training Program Description*[116]
- PP-AS-1203 *Corrective Action Program*[6]
- PP-CONOPS-03.2 *Conduct of Drills*[6]
- PP-CONOPS-08 *Notifications*[6]
- PP-DC-3002 *Records Management*[6]
- PP-EN-5035 *System Health Reporting and Operability Assessments*[6]
- PP-MN-8718 *Portable Compressed Gas Systems*[6]
- PP-MN-8740 *Maintenance Work Planning and Control*[6]
- PP-OP-8525 *Chemical Receipt and Inventory Control*[6]
- PP-QA-4701 *Surveillance Program*[6]

- PP-SH-4410 *Housekeeping and Sanitation*[6]
- PP-SH-4416 *Control of Hot Work*[6]
- PP-SH-4445 *Confined Spaces*[6]
- PP-SH-4460 *Hazard Communication*[6]
- PP-SH-4461 *Safe Handling, Use and Storage of Chemicals*[6]

The following ICDs outline the interface with SWPF and other organizations at SRS:

- V-ESR-J-00012[93]
- V-ESR-J-00017[95]

The following Programmatic Compliance Assessment Reports (PCARs) outline the documents that implement and meet all requirements of the DOE Orders:

- PCAR-FP-001 *Programmatic Compliance Assessment Report for DOE O 420.1B Chapter II (Fire Protection Design and Construction)*[117]
- PCAR-FP-002 *Programmatic Compliance Assessment Report for DOE-STD-1088-95 (Fire Protection for Relocatable Structures)*[118]
- PCAR-FP-003 *Programmatic Compliance Assessment Report for DOE O 420.1C Chapter II (Fire Protection Program and Operations)*[119]

The detailed description of the active and passive fire protection systems at SWPF is found in the Fire Detection/ Protection System Description:

- F-SD-J-00001[43]

Other supporting documents have been prepared and are used to implement various aspects of the Fire Protection Program. These documents provide an analysis of fire alarm horns in high noise areas and provide the MAQs for specific areas based on the tables in the Codes and the specific limitations of each area:

- F-ESR-J-00007[96]
- F-ESR-J-00008 *Maximum Allowable Quantities (MAQs) of Hazardous Materials by Area*[120]

3.7.2 Program Assessment

The first annual Fire Protection Program Self-Assessment required by DOE O 420.1C[105] was performed by an independent consultant (see 30448-SDC-001, *Independent Assessment of Fire Protection Program Plan SWPF*[121]) in March 2018. The review concluded that the facility and associated support building meet occupancy requirements and that the fire protection program was generally effective with some notable practices, and some findings, recommendations, and suggested improvements. Generally, this report concluded that more detail was needed in the system testing procedures. As a result, the CMMS is currently undergoing improvements. Additional instructions are being added to the CMMS Work Orders for performing fire protection

testing. The report concluded that the Fire Protection Program is adequate. Below are the findings from this report. All findings have been resolved by the SWPF Project Team via the Condition Report system.

- Finding 1 - The duration required to repair low impact system deficiencies periodically exceeds the self-imposed target of 90 days. This has been improved.
- Finding 2 - Two control valves were identified as not being checked by the Operations Inspection Rounds. This has been corrected.
- Finding 3 – The Fire Department was not able to identify system impairments at SWPF. This has been corrected.

Additional Recommendations and Suggested Improvements in the report were corrected via the Condition Report system. Refer to the report for more information.

Facility Assessments were being performed in 2019 by this same independent contractor for the Administration Building and the J Area Warehouse. These reports are still in draft form.

A Management Self-Assessment (MSA)-18-01, *Management Self Assessment 2.2 Chemcial Operations Interim Report*[122], was performed in 2018. This report concluded that fire protection objectives were met and do not require further evaluation. The assessment found some items not up to code. These items are being corrected.

S-TSR-J-00001, *SWPF Technical Safety Requirements*[123], credits the Fire Protection Program as an administrative control to minimize fire threats to the public and to minimize fire hazards to site personnel. The Fire Protection Program is to address fire prevention and fire control. The TSR credits the CPA walls and ceilings around the WTE and the Process Vessel Cells (Fire Area 1) to act as a fire barrier for internal and external fires. Also, the DSS Coalescer and the vessels in the Process Cells are credited for being grounded. These items have been designed and installed in accordance with applicable codes and are deemed adequate.

In addition, the CSE assesses the FP systems several times a month and prepares a monthly System Health Review using PP-EN-5035, *System Health Reporting and Operability Assessments*[6]. These reports are filed in the SWPF database.

In conclusion, the fire protection program is moving from a construction/commissioning mode to an operational mode. It is determined that the fire protection program is adequate and meets all DOE requirements.

3.8 Fire Loss Analysis

3.8.1 Maximum Possible Fire Loss/Most Probable Fire Scenario/Maximum Credible Fire Loss

The cost of the SWPF is not separated into functional areas, so the lump sum value ($261,000,000) of the bulk commodities and individual equipment in the SWPF Process Building (221-J) and the AFF (221-3J), was used to determine the value of each Fire Area based on the square footage of that area. When a Fire Area occupies more than one floor, the area used by that space was added

to the total floor area of that Fire Area. For example, Fire Area 1 contains the large process tanks in the dark cells, which occupy space on level 100, 116 and 124. This tripled the floor area for that fire area and allowed for a more appropriate cost for areas with high value equipment that occupied multiple floors. The resultant value per ft^2 is approximately $1500. This evaluation was initiated for compliance with DOE-STD-1066-99[15], which requires a redundant Fire Protection System for a Fire Area MPFL that exceeds $50 million. As shown in the table below, the total value of each area and the MPFL of each is less than $50 million. Table 3-6 presents the monetary values of each Fire Area rounded up to the next million dollars.

Clean-up costs are included in all areas even though some areas will not be accessible once operations begin. These areas primarily are the dark cells. Clean up of some areas may include "clean" cleanup costs and "contaminated" cleanup costs. Refer to PP-EN-5022[6] for values used for each type of area.

These values have not been escalated to present dollars. If these numbers were escalated, the $50 million MPFL limit in 1999 dollars would be escalated to $75.76 million in 2018 dollars using an average 2.28% rate of inflation per year. The $47 million value of Fire Area 1 in 2008 dollars would be escalated to $55.11 million in 2018 dollars. All other values would be well below the limit.

Table 3-6. Monetary Values

Fire Area No.	Description	Area Attributed to Fire Area (ft^2)	Total Value of Area + Clean-up = Total
1.	Process Vessel Cell Area (R191, R192, R193, R194, R195, R196) and Waste Transfer Enclosure (R190) (Cleanup costs at \$600 / ft^2)	22,230	\$34,000,000 + \$13,000,000 = \$47,000,000
2.	North ASP P&VG (R131, R131A, R131B, R131C, R131D, R131E, R131F), South ASP and CSSX P&VG (R135, R135A, R135B, R135C, R136, R136A, R136B, R136C, R136D, R136E, R136F, R136G), Material Staging and Storage Area (R130, R132, R132A, R132B, R132C, R133, R133A), West CSSX Tank Cell (R138), Back-up Air Receiver Storage (R180), (R181), (R290), all four stair shafts and the Equipment Lift shaft (Cleanup costs at \$100 / ft^2 Rad areas and \$50 / ft^2 clean areas)	27,282	\$42,000,000 + \$2,000,000 = \$44,000,000
3.	Control Room, IT Server Room (R116, R116A, R116B, R117, R118, R118A) (Cleanup costs at \$50 / ft^2)	2,487	\$4,000,000 + \$130,000 = \$4,130,000
4.	North and East Facility Support Area (R100, R100A, R100B, R100C, R101, R102, R103, R104, R105, R106, R107, R108, R109, R109A, R109B, R109C, R110, R111, R111A, R111B, R111C, R112, R113, R114, R115, R120, R120A, R120B, R120C, R120D, R121, R122, R123, R124, R125, R126, R126A, R126B, R126C, R127, R127A, R128, R129, R129A, R182, and R183) (Cleanup costs at \$50 / ft^2)	24,265	\$37,000,000 + \$1,200,000 = \$38,200,000
5.	Exhaust HEPA Filter and Fan Rooms at 116-ft elevation (R202 and R203) (Cleanup costs at \$600 / ft^2)	15,468	\$24,000,000 + \$9,200,000 = \$33,200,000
6.	Contactor Support Floor and Contactor Operating Deck (R216 and R252) (Cleanup costs at \$600 / ft^2)	4,047	\$7,000,000 + \$2,400,000 = \$9,400,000
7.	Cell Inlet HEPA Filter Room #2 at 116-0 ft, Filter Storage and Drop Area at 116-0 ft, CSSX Tank Cell Operating Deck (R201, R201A, R211, R212, R212A, R213, R214, R250, R251) (Cleanup costs at \$600 / ft^2)	17,685	\$27,000,000 + \$10,600,000 = \$37,600,000
8.	Process Vessel Cell Operating Deck (R301, R301A, R310A, R310B, R310C, R310D, and R311) (Cleanup costs at \$600 / ft^2)	10,060	\$16,000,000 + \$6,000,000 = \$24,000,000
9.	HEPA Filter Rooms and Laboratory Hot Cell Exhaust Room at 139-0 ft (R302, R302A, R303, and R304) (Cleanup costs at \$600 / ft^2)	9,999	\$16,000,000 + \$6,000,000 = \$24,000,000
10.	Cold Chemicals Area (R150, R150A, R150B, R150C, R150D, R150E, R151, R152, R153, R154, R154A, R155, R156, R157, and R158) (Cleanup costs at \$50 / ft^2)	10,582	\$16,000,000 + \$500,000 = \$16,500,000
11.	AFF (R140, R141, R142, R143, R143A, R144, and R145) (Cleanup costs at \$100 / ft^2)	10,463	\$16,000,000 + \$1,000,000 = \$17,000,000
12.	AFF HEPA Filter Room (R146) (Cleanup costs at \$100 / ft^2)	1,046	\$2,000,000 + \$100,000 = \$2,100,000

Table 3-6. Monetary Values (cont.)

Fire Area No.	Description	Area Attributed to Fire Area (ft^2)	Total Value of Area + Clean-up = Total
13.	Analytical Laboratory Area and Hot Cell (R300, R300A, R312, R312A, R312B, R312C, R312D, R313, R314, R315, R315A, R316, R317, R318, R319, R319A, and R320) (Cleanup costs at \$100 / ft^2 Rad areas and \$50 / ft^2 clean areas)	10,198	\$16,000,000 + \$900,000 = \$16,900,000
14.	South Utility Chase, Contactor Support Floor Chase, and West Utility Chase (R215, R216A, and R253) (Cleanup costs at \$600 / ft^2)	4,121	\$7,000,000 + \$2,500,000 = \$9,500,000
15.	East CSSX Tank Cell (R138A) (Cleanup costs at \$600 / ft^2)	794	\$2,000,000 + \$500,000 = \$2,500,000
16.	HVAC Shielding Chase (R204) (Cleanup costs at \$600 / ft^2)	2,910	\$5,000,000 + \$3,500,000 = \$8,500,000
	Totals	179,448	\$334,530,000

3.9 Hazardous Material Release Analysis

A comprehensive review of hazards associated with the SWPF was performed to identify potential accident scenarios. To determine the unmitigated risk of identified accidents, a comprehensive Hazard Evaluation was performed. For purposes of a conservative analysis, all process tanks were assumed to be at maximum capacity volumes. Results of the Hazard Evaluation for the SWPF are documented in V-PHR-J-00007, *SWPF Hazard Analysis*[124].

3.9.1 Radioactive Material

As part of the Hazard Evaluation process, an assessment was performed to determine the radiological consequence level for selected unmitigated events. No credible accident scenarios resulting from fire in the SWPF exceeded Evaluation Guidelines for the maximally exposed offsite individual.

Several credible unmitigated accident scenarios for fires analyzed in V-PHR-J-00007[124], resulted in a radiological exposure greater than the threshold of concern to the facility worker. These scenarios are associated with fires in the P&VGs and West CSSX Tank Cell, resulting from combustible solvents and organic wastes. These areas of the SWPF Process Building are provided with automatic fire suppression systems and other mitigating controls, which will assist in limiting these potential exposures to an acceptable level. For further description of the fire protection systems and other mitigating controls in these areas, see Section 3.2.

Several credible unmitigated accident scenarios for explosions resulted in a radiological exposure greater than the threshold of concern to the co-located worker and the facility worker. These explosions were caused by the accumulation of H^2 and flammable organics in the process vessels.

The process vessels where explosions are credible are located in unoccupied areas of the facility. Also, controls such as the ADS are provided to prevent the explosions from occurring.

3.9.2 Hazardous Materials

Chemicals stored and used at the SWPF will not be present in quantities that, if released, could result in consequences that exceed chemical exposure guidelines for offsite and onsite individuals. Chemical control areas are generally segregated by the Fire Areas in the building. Chemical exposure levels due to chemical releases were assessed by the following calculations to determine airborne concentrations at 100 meters and at the SRS boundary:

- Q-CLC-J-00052, *Radiological Air Emissions, Dispersion, and Dose Assessment for Normal Operations of Ventilated Tanks and Vessels*[125];
- Q-CLC-J-00002, *SWPF Mercury Emission Rate*[126];
- Q-CLC-J-00003, *SWPF Nitric Acid and NO_X Emission Rates*[127];
- Q-CLC-J-00004, *SWPF Volatile Organic Compound Air Emission Rate*[128]; and
- Q-CLC-J-00005, *Evaluation of the SWPF Stack Height*[129].

No credible accident scenarios resulting from fire in the SWPF exceeded the Temporary Emergency Exposure Limit for the onsite and offsite receptors.

3.10 Review of Existing Fire Protection Findings

There are no existing fire protection findings for the SWPF. The previous revision of this FHA created Open Items. Old Open Items have been closed and new Open Items have been created for this revision, which are tabulated in Section 4.2.

4.0 ANALYSIS RESULTS AND CONCLUSIONS

4.1 Summary of Analysis Results

This FHA concludes that the current level of protection from fire-related loss (regarding installed features and programmatic aspects) at the SWPF is sufficient to achieve the HPR and life safety objectives set forth by DOE. This report identifies both the minimum code requirements and the deviations from standard fire protection practices, as well as alternate protection where deemed prudent.

The facility meets objective requirements that provide an acceptable degree of life safety to DOE and contractor personnel. There are no undue hazards to the public from fire and its effects on DOE facilities. This objective is met because the consequences from a chemical or radiological release do not exceed the onsite or offsite limits. A fire in this facility will not cause an offsite release of radioactive material or other hazardous material that will threaten public health and safety or the environment because the offsite limits for chemical and/or radiological releases are not challenged.

The SWPF is currently in the Commissioning phase. Open Items are tabulated below. These Open Items are noted for the sole purpose of tracking and identification of potential deficiencies. Each item has several alternative paths to achieve full compliance with applicable DOE Orders and Standards.

4.2 Tabulation of Open Items

Technically, there are no anticipated deficiencies for the SWPF, due to the stage of design and construction for the facility. However, the remaining Open Items must be either 1) properly addressed during the course of Commissioning, or 2) have adequate provisions in place prior to Hot Operations.

Operations Issues:

1. Operations Open Item (OOIT-117) is open to create Administrative Controls for access to the Contactor Operating Deck (R252). Access to the Contactor Operating Deck will be controlled by SOP-ENTRY-001[6] and is expected to occur less than 10 times per year.
2. A revision to the SRS Fire Department BNA is required to change the SWPF status from a Pre-Operational Phase to an Operational Phase.
3. Completion of Fire Door repairs.
4. Completion of MSA 2.2 Sprinkler System items.
5. Completion of MSA 2.2 Stair Guard Rail items.
6. Resolve the use of Pyrophoric material in the Analytical Laboratory.
7. Calculation of Manual HEPA spray sprinklers.
8. Provide better signage when exiting Stair #2 from the upper floors in an emergency. Emergency egress should into the NFSA Corridor rather than into the CPA.
9. Completion of Fire Alarm Audibility items. There are still some rooms with audibility issues.
10. Revise PP-EN-5012[6], FHA procedure to remove the requirement to list the value of each piece of equipment over $1 million.
11. Revise F-SD-J-00001[43], FP System Description to update fire alarm system description and other items as deemed necessary.

4.3 Conclusions

The SWPF complies with S-RCP-J-00001, *SWPF Standards/Requirements Identification Document*[130], which encompasses applicable NFPA Codes and Standards and DOE Orders and Standards. The facility meets the HPR factors, limiting damage to an acceptable level. Loss potential does not exceed acceptable limits. Life safety features, such as exit access and travel distances, meet the intent of NFPA 101[24], providing a high degree of "safety to life from fire". There are no scenarios that yield unacceptable radiological releases to the public.

This FHA concludes that, provided the identified issues are addressed during Start-up and Commissioning, the level of protection from fire-related loss is sufficient to achieve the HPR and life safety objectives set forth by DOE.

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