SALT WASTE PROCESSING FACILITY

BALANCE OF PLANT BASIS OF DESIGN

DELIVERABLE: 3.3

Contract No. DE-AC09-02SR22210
Phase II

Function: Design Requirements
Doc. No.: P-DB-J-00004
Revision: 7
Date: 03/07/2017
SIGNATURE PAGE

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### SUMMARY OF CHANGES

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LIST OF ACRONYMS AND ABBREVIATIONS

%  Percent
°F  Degrees Fahrenheit
AASHTO  American Association of State Highway and Transportation Officials
AC  Alternating Current
ACI  American Concrete Institute
ADS  Air Dilution System
AFF  Alpha Finishing Facility
AFP  Alpha Finishing Process
AGMA  American Gear Manufacturers Association
AHU  Air Handling Unit
AIHA  American Industrial Hygiene Association
AISC  American Institute of Steel Construction, Inc.
ALARA  As Low As Reasonably Achievable
ANSI  American National Standards Institute
APA  Air Pulse Agitator
API  American Petroleum Institute
ARI  Air-Conditioning and Refrigeration Institute
ARM  Area Radiation Monitor
ARP  Actinide Removal Process
ASCE  American Society of Civil Engineers
ASDT  Alpha Sorption Drain Tank
ASHRAE  American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME  American Society of Mechanical Engineers
ASP  Alpha Strike Process
AST-A  Alpha Sorption Tank-A
AST-B  Alpha Sorption Tank-B (in the Alpha Finishing Process)
ASTM  American Society for Testing and Materials
ATS  Automatic Transfer Switch
AWWA  American Water Works Association
Ba  Barium
BMP  Best Management Practices
BOD  Basis of Design
BPCS  Basic Process Control System
CAM  Continuous Air Monitoring
CCA  Cold Chemicals Area
CCTV  Closed-circuit television
CFF  Cross-Flow Filter
CFR  Code of Federal Regulations
CHWS  Chilled Water System
Ci  Curie
CIP  Clean-in-Place
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<tr>
<td>EEO</td>
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<td>EFSA</td>
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<td>EG</td>
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<td>EPC</td>
<td>Engineering, Procurement, and Construction (Contractor)</td>
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<td>Filter Feed Tank-A</td>
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<tr>
<td>FFT-B</td>
<td>Filter Feed Tank-B (in the Alpha Finishing Process)</td>
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<tr>
<td>ft</td>
<td>Feet/Foot</td>
</tr>
<tr>
<td>GA</td>
<td>General Arrangement (drawings)</td>
</tr>
<tr>
<td>gpm</td>
<td>Gallons per minute</td>
</tr>
<tr>
<td>GS</td>
<td>General Service</td>
</tr>
<tr>
<td>H₂C₂O₄</td>
<td>Oxalic acid</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>---------</td>
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<tr>
<td>HAOP</td>
<td>Hazard and Operability Review</td>
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<td>HEPA</td>
<td>High-Efficiency Particulate Air</td>
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<td>High-Intensity Discharge</td>
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<td>High-Level Waste</td>
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<td>HNO₃</td>
<td>Nitric Acid</td>
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<td>Instrumentation and Controls</td>
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<td>IPC</td>
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<td>ISA</td>
<td>International Society of Automation and Control</td>
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<td>IST</td>
<td>Intermediate Storage Tank</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ksi</td>
<td>Kips per square inch</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt</td>
</tr>
<tr>
<td>kW</td>
<td>Kilowatt</td>
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<tr>
<td>lb</td>
<td>Pound</td>
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<tr>
<td>LIMS</td>
<td>Laboratory Information Management System</td>
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<td>LLW</td>
<td>Low-level Waste</td>
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<td>LPPP</td>
<td>Low-Point Pump Pit</td>
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<td>LWO</td>
<td>Liquid Waste Operations</td>
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<td>M&amp;O</td>
<td>Management and Operating (Contractor)</td>
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<td>MBM</td>
<td>Mass Balance Model</td>
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<tr>
<td>MCC</td>
<td>Motor Control Center</td>
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<tr>
<td>MCU</td>
<td>Modular Caustic-Side Solvent Extraction (CSSX) Unit</td>
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<tr>
<td>Mgal</td>
<td>Million gallons</td>
</tr>
<tr>
<td>MOI</td>
<td>Maximally Exposed Offsite Individual</td>
</tr>
<tr>
<td>mph</td>
<td>Miles per hour</td>
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<tr>
<td>mRem</td>
<td>Millirem</td>
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<tr>
<td>MSL</td>
<td>Mean sea level</td>
</tr>
<tr>
<td>MSS</td>
<td>Manufacturers Standardization Society</td>
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<tr>
<td>MST</td>
<td>Monosodium Titanate</td>
</tr>
<tr>
<td>MTBF</td>
<td>Mean Time Between Failures</td>
</tr>
<tr>
<td>MTTR</td>
<td>Mean Time To Repair</td>
</tr>
<tr>
<td>N/A</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>NaOH</td>
<td>Sodium Hydroxide (Caustic)</td>
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<td>Nuclear Criticality Safety Evaluation</td>
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<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
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<td>NFSA</td>
<td>Northern Facility Support Area</td>
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<td>NPDES</td>
<td>National Pollutant Discharge Elimination System</td>
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<td>NPH</td>
<td>Natural Phenomena Hazards</td>
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<td>NRSW</td>
<td>Non-radioactive solid waste</td>
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<td>O&amp;M</td>
<td>Operations and Maintenance</td>
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<tr>
<td>P&amp;ID</td>
<td>Piping and Instrumentation Diagram</td>
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<td>Pump and Valve Gallery</td>
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<td>PC</td>
<td>Performance Category</td>
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<td>PCHW</td>
<td>Process Chilled Water</td>
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<td>PDS</td>
<td>Plant Design System</td>
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<td>PI</td>
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<td>Potential Impact Category</td>
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<td>PIN</td>
<td>Plant Information Network</td>
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<td>PMF</td>
<td>Probable Maximum Flood</td>
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<tr>
<td>PMVS</td>
<td>Pulse Mixer Ventilation System</td>
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<tr>
<td>PP</td>
<td>Project Procedure</td>
</tr>
<tr>
<td>psf</td>
<td>Pounds per square foot</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds per square inch</td>
</tr>
<tr>
<td>psig</td>
<td>Pounds per square inch gauge</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
</tr>
<tr>
<td>PVVS</td>
<td>Process Vessel Ventilation System</td>
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<td>PW</td>
<td>Process Water</td>
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<td>RBA</td>
<td>Radiological Buffer Area</td>
</tr>
<tr>
<td>rem</td>
<td>Roentgen Equivalent Man</td>
</tr>
<tr>
<td>RFI</td>
<td>Request for Information</td>
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<td>SC</td>
<td>Safety Class</td>
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<td>SCDHCE</td>
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<td>South Carolina Regulation</td>
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<td>Strip Effluent Hold Tank</td>
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<td>Safety Instrumented Function</td>
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<td>Safety Instrumented Systems</td>
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<td>Sheet Metal and Air Conditioning Contractors’ National Association</td>
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<td>SPF</td>
<td>Saltstone Production Facility</td>
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<td>Sr</td>
<td>Strontium</td>
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<td>SRS</td>
<td>Savannah River Site</td>
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LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

SRSSOC  Savannah River Site Operations Center
SS     Safety Significant
SSC    Structure, System, and Component
SSFT   Salt Solution Feed Tank
SSP    Safe Shutdown Panel
SSRT   Sludge Solids Receipt Tank
STS    Sample Transfer System
SWPF   Salt Waste Processing Facility
SWPPP  Stormwater Pollution Prevention Plan
TCDS   Telecommunications and Control Datalink System
TEDE   Total Effective Dose Equivalent
TEMA   Tubular Exchanger Manufacturers Association
UL     Underwriters Laboratory
UPS    Uninterruptible Power Supply
V      Volt
VAC    Volts Alternating Current
VDC    Volts Direct Current
VFD    Variable-Frequency Drive
WAC    Waste Acceptance Criteria
WSRC   Washington Savannah River Company
WTE    Waste Transfer Enclosure
WTL    Waste Transfer Line
WWHT   Wash Water Hold Tank
1.0 PURPOSE AND SCOPE

The purpose of this document is to describe the design basis and specify the design requirements and design codes and standards to be used in development of the Salt Waste Processing Facility (SWPF). A description of the SWPF structures, systems, and components (SSCs) is also provided. The Basis of Design (BOD) document was originally developed during Conceptual Design and has been progressively updated as the SWPF Project has evolved. The BOD developed for Preliminary Design (P-DB-J-00001, SWPF Basis of Design\(^1\)) was split into two documents, P-DB-J-00003 (SWPF Process Basis of Design\(^2\)) and this document. This BOD and P-DB-J-00003 supersede P-DB-J-00001 and are intended to meet the requirements of Standard 3, Section (b)(2) of the Contract between the Engineering, Procurement, and Construction (EPC) Contractor and the U.S. Department of Energy (DOE) (DE-AC09-02SR22210, Design, Construction, and Commissioning of a Salt Waste Processing Facility (SWPF)\(^3\)).

This Balance of Plant BOD provides design information, requirements, codes, and standards that document the current Technical Baseline for the SWPF. The Balance of Plant BOD is consistent with approved Design Change Requests (DCRs) and Design Change Notices (DCNs) for the SWPF and will serve as the foundation for development of the SWPF Design. This BOD and P-DB-J-00003\(^2\) will be updated to incorporate design changes that are implemented in accordance with P-CDM-J-00001, SWPF Configuration Management Plan\(^4\). Any changes to the BOD documents are subject to the change control provisions specified in the EPC’s Project Procedure (PP)-EN-5001, Design Control contained in the SWPF Project Procedures Manual\(^5\).

2.0 SWPF MISSION

Nuclear material production operations at the Savannah River Site (SRS) resulted in the generation of radioactive waste that was sent to the F- and H-Area Tank Farms for storage. Approximately 37 million gallons (Mgal) of radioactive waste is currently being stored on an interim basis in 49 existing underground waste storage tanks in the F- and H-Area Tank Farms. The radioactive waste in these tanks includes approximately 3 Mgal of sludge, containing precipitated solids and insoluble waste, and 34 Mgal of salt solution and crystallized salts.

Continued long-term storage of radioactive waste in underground tanks poses an environmental risk. There are two regulatory drivers for waste removal: WSRC-TR-94-0608, Savannah River Site Approved Site Treatment Plan, 2005 Annual Update\(^6\) and WSRC-OS-94-92, Federal Facility Agreement for the Savannah River Site\(^7\). WSRC-TR-94-0608 requires that all radioactive waste stored in the tanks be processed by 2028. WSRC-OS-94-92 requires that tanks without full secondary containment be emptied and closed by 2022 on an approved tank-by-tank schedule.
Waste in the tanks is comprised of three forms:

1. Precipitated Sludges – approximately 3 Mgal of primarily metal oxides containing over one-half the total inventory of radioactive material within the tanks;
2. Saltcake – approximately 16 Mgal of salt precipitate; and

Considerable liquid is mixed interstitially with the precipitated sludge and saltcake. The interstitial liquid is estimated to be 30 percent (%) of the saltcake volume and 70% of the sludge volume. Additionally, water will need to be added to dissolve the saltcake and to wash sludge that has been removed. The water added for waste removal, sludge washing, and the continued generation of radioactive waste by other SRS facilities will increase the total salt solution volume to be processed to approximately 84.7 Mgal.

The waste removal process involves mobilizing and pumping liquids and sludge from the tanks and dissolution and pumping of the saltcake waste. The sludge waste is pretreated by a sludge washing process and sent to the Defense Waste Processing Facility (DWPF) for vitrification. Salt solutions removed from the tanks after SWPF startup (including supernate, interstitial liquids, and dissolved saltcake) will be processed by the SWPF.

The processing pathways for all radioactive waste streams are shown in Figure 2-1. Prior to SWPF startup, some limited quantity of salt solutions that are relatively low in Curie (Ci) content will be processed by Deliquification, Dissolution, and Adjustment (DDA), the Actinide Removal Process (ARP), and a Modular Caustic-side Solvent Extraction (CSSX) Unit (MCU). After SWPF startup, salt solutions from the Tank Farm will be transferred to the SWPF for treatment. At that time, waste feed to the ARP and MCU processing will be discontinued.

The supernate and any dissolved saltcake solutions removed from various tanks that are to be treated by the SWPF will be sent to blending and staging tanks to prepare batches for processing at the SWPF. Each SWPF feed batch collected in a blending and staging tank will be analyzed for chemical and radionuclide concentrations prior to delivery to the SWPF Feed Tank located in the H-Area Tank Farm. Waste from the SWPF Feed Tank will be transferred directly to the SWPF in small-quantity “mini-batches” (approximately 23,200 gallons each). After multiple mini-batches have been processed by the SWPF, and the SWPF Feed Tank inventory has been partially depleted, additional waste will be transferred into the SWPF Feed Tank from a blending and staging tank as a large “macro-batch”.

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SWPF Balance of Plant Basis of Design

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Figure 2-1. Radioactive Liquid Waste Disposition Baseline

* Transfers of salt solution to ARP will be discontinued after SWPF startup.
The SWPF mission is to process all of the high-Ci salt waste and the remaining fraction of lower-Ci waste not processed by DDA, the ARP, and/or the MCU. Pretreatment of salt waste at the SWPF is intended to remove and concentrate the radioactive cesium (Cs), strontium (Sr), and actinides from the bulk salt solution feed. The concentrated waste containing the Cs, Sr, and actinide constituents will be sent to the DWPF, where the waste will be immobilized in glass through a vitrification process. The bulk decontaminated salt solution (DSS) will be sent to the Saltstone Production Facility (SPF) for immobilization in a grout mixture and disposed in grout vaults. However, the DSS transfer pump is sized to allow the DSS effluent to be sent directly to the SPF or to Tank 50.

3.0 INTEGRATION OF DESIGN REQUIREMENTS

This BOD defines design requirements, including industrial codes and standards for SSCs and sub-systems. Additional information regarding the basis of design for process systems is contained in P-DB-J-00003. Specific design requirements for environmental protection, nuclear safety, operations and maintenance (O&M), functional performance, and sampling and analysis have been developed and issued separately. These supplemental design requirement documents are listed in Table 3-1.

This BOD, P-DB-J-00003, and P-DB-J-00002, SWPF Design Criteria Database, provide the complete library of Code of Record design requirements for the SWPF. P-DB-J-00002 incorporates the design requirements identified in this BOD, P-DB-J-00003, and the supplemental design input requirement documents listed in Table 3-1. P-DB-J-00002 will be updated should additional design requirements be identified through design reviews and evaluations. Figure 3-1 depicts the P-DB-J-00002 inputs.
Table 3-1. Supplemental Design Input Requirements Documents

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<tr>
<th>Document Number</th>
<th>Document Title</th>
<th>Design Requirements Addressed</th>
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<tr>
<td>DE-AC09-02SR22210</td>
<td>Contract</td>
<td>Facility Specifications</td>
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<td>S-RCP-J-00001</td>
<td>SWPF Standards/Requirements Identification Document</td>
<td>Environmental, Safety, and Health Requirements</td>
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<td>S-EIP-J-00001</td>
<td>SWPF Environmental Plan</td>
<td>Environmental Permitting and Regulatory Requirements</td>
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<td>S-SAR-J-00001</td>
<td>SWPF Preliminary Documented Safety Analysis</td>
<td>Engineered SSCs and Safety Functions</td>
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<td>P-ESR-J-00011</td>
<td>SWPF Operations Requirements Document</td>
<td>Operability, Maintainability, and Testability Design Features/Requirements</td>
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<td>P-ESR-J-00011</td>
<td>SWPF Functional Specification</td>
<td>Performance Requirements and Functional Requirements</td>
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<td>SWPF Stormwater Interface Control Document (ICD-04)</td>
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<td>SWPF Radioactive Liquid Effluents Interface Control Document (ICD-05)</td>
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<td>SWPF Liquid Sanitary Wastes Interface Control Document (ICD-06)</td>
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<td>SWPF Facility Siting Interface Control Document (ICD-07)</td>
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<td>SWPF Waste Treatability Samples Interface Control Document (ICD-11)</td>
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<td>SWPF Telecommunications and Controls Datalink System Interface Control Document (ICD-13)</td>
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<td>SWPF Work Controls Interface Control Document (ICD-18)</td>
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### Table 3-1. Supplemental Design Input Requirements Documents (cont.)

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<td>SWPF Training Interface Control Document (ICD-20)²⁹</td>
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<td>SWPF Non-Radioactive Solid Waste Interface Control Document (ICD-21)³⁰</td>
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<td>V-ESR-J-00022</td>
<td>SWPF Document Control Interface Control Document (ICD-22)³¹</td>
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<td>SWPF Financial Reporting Interface Control Document (ICD-23)³²</td>
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<td>SWPF Radiological Controls Interface Control Document (ICD-27)³³</td>
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<td>P-FDD-J-00001</td>
<td>SWPF Analytical Laboratory Design Requirements³⁴</td>
<td>Sampling and Analysis Requirements and Laboratory and Sampling System Requirements</td>
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<td>S-SRI-J-00001</td>
<td>SWPF Facility Security Plan³⁵</td>
<td>Physical Security Requirements</td>
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<td>V-QP-J-00001</td>
<td>SWPF Quality Assurance Plan³⁶</td>
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<td>HACN-0002</td>
<td>HazOp Review Update for Dispositioned Recommendations³⁷</td>
<td>Operational and Nuclear Safety Aspects of the Entire Facility</td>
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</table>
4.0 FEED AND PRODUCT SPECIFICATIONS

The SWPF process removes and concentrates dissolved Cs, Sr, actinides, and suspended solids. The SWPF product must meet the receiving facilities’ (SPF and DWPF) Waste Acceptance Criteria (WAC) after this processing. The sending facility (H-Tank Farm) must meet SWPF WAC prior to transferring to SWPF. Species that SWPF does not affect must comply with the SWPF feed specification to ensure that the SWPF product meets the SPF WAC and SWPF feed specification.

The SWPF design includes a limit on the $^{137}$Cs concentration in the waste feed of 5.25 Ci per gallon for shielding and nuclear safety reasons. The EPC will continue to work with the Liquid Waste Operations and Site Management and Operating (LWO and M&O) Contractors to develop criticality limits acceptable to all interfacing facilities.

The SWPF Analytical Laboratory design has incorporated the capability to support the analyses requirements specified in X-ESR-J-00001, SWPF, Feed Waste Acceptance Criteria\textsuperscript{38}, X-WCP-J-00001, SWPF Waste Compliance Plan for Decontaminated Salt Solution Transfers to Tank 50\textsuperscript{39} and X-WCP-J-00002, SWPF Waste Compliance Plan for Transfers to the Defense Waste Processing Facility\textsuperscript{40}. 
The design assumptions for Sr/actinide Decontamination Factor values for various MST strike options (i.e., single-strike or multi-strike) and Cs removal are documented in P-DB-J-00003.2.

5.0 PLANT CAPACITY/THROUGHPUT

The Process basis of design, including capacity of the SWPF process systems, is documented in P-DB-J-00003. The SWPF design is based on processing each 23,200-gallon batch of waste feed in 21.6 hours. This processing rate results in an instantaneous maximum design capacity of 9.4 million gallons per year.

6.0 FACILITY LOCATION

The SWPF is located in J-Area, east of the Low-Point Pump Pit (LPPP) and southeast of the DWPF, as shown in Figure 6-1. This location provides convenient WTL and utility tie-ins and allows coordination with O&M staff resources and support functions (training, waste sample analysis, environmental monitoring, etc.). The environmental impacts associated with SWPF construction at this location have been extensively evaluated and are documented in DOE/EIS-0303, High-Level Waste Tank Closure Final Environmental Impact Statement.41 J-Area shares the same climate, geology, and natural phenomena hazards (NPH) as the DWPF. The environmental conditions for the DWPF, as described in WSRC-SA-6, Final Safety Analysis Report, Savannah River Site, Defense Waste Processing Facility42 are, therefore, generally applicable to the SWPF. The climate and NPH attributed to J-Area in this BOD are consistent with the data provided in Chapter 3 of WSRC-SA-6 and G-SAR-G-00001, Generic Safety Analysis Report (GSAR)43.

6.1 Climate

The average rainfall for the area is 48 inches per year, with the majority (about 65%) occurring during the spring and summer months. The wind direction primarily comes from the southeast in J-Area, with an average speed between two and five miles per hour (mph). The average high for January (coldest month) is 58 degrees Fahrenheit (°F), with the average low being 33°F. The average high for July (warmest month) is 94°F, with the average low being 70°F. The observed temperature extremes range from 107°F to -3°F. SWPF design will be based on the 99 percentile seasonal high and low temperatures published in 2001 by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) (2001 ASHRAE Fundamentals Handbook).44 See Section 14.2 for additional details. Snow accumulations in excess of 1 inch are rare, occurring on an average of once every five years. For a nine-year period of record reported by Tattelman No. AFCRL-TR-73-0646, Estimated Glaze Ice and Wind Loads at the Earth’s Surface for the Contiguous United States,45 accumulation of ice on exposed surfaces
Figure 6-1. Site Location
occurred in the SRS area an average of once every two years. The 100-year recurrence ice storm is estimated to produce an accumulation of approximately 0.67 inches of surface ice. Severe weather events are discussed in Section 6.3.1.

6.2 Geotechnical

DOE/EIS-0082-S2, Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement\textsuperscript{46} provides general geotechnical data for J-Area. This data was supplemented with the siting and preliminary geotechnical investigation performed for the portion of J-Area then referred to as Site B and documented in K-TRT-S-00001, \textit{Preliminary Siting Characterization Salt Disposition Facility – Site B}\textsuperscript{47}. This preliminary investigation was performed to serve as a baseline characterization program to determine the suitability of the site and to serve as a guide for performing SWPF-specific geotechnical investigations. The geotechnical engineering investigation completed for SWPF is documented in 22-1-02374-500, \textit{Geotechnical Engineering Report: Geotechnical Investigation, Phase II, Salt Waste Processing Facility}\textsuperscript{48} and K-ESR-J-00002, \textit{SWPF Dynamic Settlement Evaluation}\textsuperscript{49}. The Geotechnical Engineering Report provides the data required to complete the final structural design at the facility.

6.3 Natural Phenomena Data

NPH evaluation includes hazards from meteorological (winds), hydrologic (rain and floods), and geologic (seismic) sources.

6.3.1 Meteorological Hazards

WSRC-IM-2004-00008, \textit{Documented Safety Analysis Support Document}\textsuperscript{50} notes that the SRS area experiences severe weather, with storms capable of developing tornado events that peak during the months of March and April. These can produce damaging winds, hail, and localized heavy rainfall, resulting in the potential for local flooding. Approximately half the tornado events occur in March, April, May, and November; however, tornadoes have been observed in the SRS region every month of the year. Over a 3-year period beginning in 1967, 165 tornadoes of F-0 to F-3 and 2 of F-4 intensity on the Fujita scale intensity category occurred within a 2-degree (latitude and longitude) square centered on SRS. SRS experiences tornado wind speeds of 169 to 214 mph for return periods of 50,000 and 500,000 years, respectively. The wind speeds to be used for structural design of the SWPF are discussed in Section 9.3.3.

6.3.2 Hydrological Hazards

As noted in WSRC-IM-2004-00008\textsuperscript{50}, tropical storms that that can deposit significant rainfall (4 to 12 inches) in a relatively short period (less than 24 hours), can occur at SRS. These tropical storms typically occur between June and November and can result in localized flooding with a potential for widespread flooding. The rain loads used in the structural design of the SWPF are described in Section 9.3.8.
J-Area slopes generally from northwest to southeast, with a high point elevation of approximately 282 feet (ft) above mean sea level (MSL) down to 268 ft above MSL. Construction within the SWPF will include regrading the existing slopes and establishing new drainage patterns. A new stormwater drainage system will direct rainwater runoff to a detention basin that will be located south of the SWPF structures. The Project will take advantage of existing topography and drainage patterns to minimize regrading of the land outside the SWPF site boundary during and after construction. Site grading activities and discharges from stormwater basins are regulated by the State of South Carolina through its permitting authority. To obtain coverage under the State of South Carolina’s National Pollutant Discharge Elimination System (NPDES) General Permits, the EPC has performed stormwater calculations and prepared a stormwater pollution prevention plan (SWPPP) (P-ERP-J-00001, SWPF Stormwater Management and Sediment Control Plan/Stormwater Pollution Prevention Plan 51). Coverage was granted by South Carolina Department of Health and Environment Control (SCDHEC) under general permit coverage number SCR10H152, effective September 14, 2007 52. Rainfall amounts used in the stormwater drainage design are presented in Section 10.2.

6.3.3 Geological Hazards

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. This event was evaluated as part of a Site-specific response spectra and was characterized as having a Moment Magnitude of 7.5 (WSRC-TR-97-0085, SRS Seismic Response Analysis and Design Basis Guidelines 53).

The Union County, South Carolina, earthquake of 1913 had an estimated magnitude of 4.5 and occurred 90 to 100 miles from SRS, as summarized in Ground Motion Following Selection of SRS Design Basis Earthquake and AssociatedDeterministic Approach 54. This earthquake is included in a group of historical epicenters that form a diffuse northwesterly trending zone from the Charleston region to the Appalachian tectonic province. Based on this information, an earthquake of up to magnitude 6.0 could theoretically occur within this zone.

In recent years, three earthquakes have occurred within the SRS boundary, as reported by local print media and cited in DOE/EIS-0303 41:

- On May 17, 1997, with a Richter magnitude of 2.3 and a focal depth of 3.38 miles; its epicenter was southeast of K-Area;
- On August 5, 1998, with a Richter magnitude of 2.0 and a focal depth of 1.6 miles; its epicenter was northeast of K-Area; and
- On June 8, 1985, with a Richter magnitude of 2.6 and a focal depth of 3.7 miles, its epicenter was south of C-Area and west of K-Area.

Seismic design for the SWPF is addressed in Section 9.3.4.
7.0 SWPF INTERFACES

ICDs provide documentation of agreements on physical facility interfaces and support services among the U.S. Department of Energy-Savannah River (DOE-SR), the EPC, and the Site LWO and M&O. ICDs define the scope and the design and administrative requirements associated with each SWPF interface. The function of an ICD is to communicate respective baseline requirements and details across interface boundaries, identify issues associated with incompatibility at an interface, and manage resolution of those issues.

The format and content requirements for the SWPF ICDs were patterned after WSRC-IM-98-00033, Systems Engineering Methodology Guidance Manual (Appendix E). The essential elements addressed by each ICD include: (1) definition of the interface boundary; (2) EPC and Site LWO and M&O responsibilities for providing utilities, infrastructure, or services; (3) interface performance requirements; (4) design criteria for physical modifications or new construction; and (5) schedule of work to be performed by both the EPC and Site LWO and M&O. ICDs have been developed for all physical interfaces and many of the essential administrative interfaces for the SWPF.

A pictorial representation of proposed interfaces and their associated ICDs is provided in Figure 7-1.
A complete list of the current revision for each ICD is maintained in V-ESR-J-00001, SWPF Interface Control Document List\textsuperscript{56}. A discussion of the general scope of each ICD is provided below.

ICD-02 (V-ESR-J-00002\textsuperscript{14}): This ICD describes the interface between the S-Area and SWPF Domestic Water (DW) Systems, specifically a tie-in by the SWPF to an existing 4-inch S-Area DW line. DW will be used to supply the Process Water (PW) and the Potable Water. PW is used for flushing and potable water is used for drinking water, safety showers, eyewash stations, and sanitary/utility services. The DW System will not supply, interconnect with, or be shared with the Fire Water Protection water supply.

ICD-03 (V-ESR-J-00003\textsuperscript{15}): This ICD describes the interface between the SWPF and Site LWO and M&O for the disposal of low-level, hazardous, mixed waste and transuranic waste generated by the SWPF. This ICD specifies waste packaging, characterization, storage of regulated solid waste at the SWPF, and transportation and disposal services provided by Washington Savannah River Company (WSRC) or others.

ICD-04 (V-ESR-J-00004\textsuperscript{16}): This ICD describes the interface between the SWPF and the Site LWO and M&O’s SCDHEC Representative for stormwater management and sediment control during SWPF Construction and Operations.

ICD-05 (V-ESR-J-00005\textsuperscript{17}): This ICD describes the interface between the SWPF and the Site LWO and M&O for the liquid radioactive low-level waste (LLW) and mixed waste effluents expected to be generated during normal operation, Hot Commissioning, and subsequent testing that occurs during initial SWPF operations. The generation of other types of radioactive liquid waste (transuranic and high-level waste [HLW]) is not anticipated during normal SWPF operations.

ICD-06 (V-ESR-J-00006\textsuperscript{18}): This ICD describes the interface between the SWPF Liquid Sanitary Waste System and the S-Area Sanitary Sewer System. The SWPF Liquid Sanitary Waste System will handle wastewater generated from restrooms, change rooms, janitorial closets, water fountains, safety showers, and eyewash stations that are located in uncontaminated areas. Condensate from air compressors and heating, ventilating, and air conditioning (HVAC) equipment will also be discharged to the Sanitary Sewer System. The system will not accept waste streams from either the process or utility lines or rainwater from building roof drains.
ICD-07  (V-ESR-J-00007\textsuperscript{19}): This ICD describes the interface between the existing SRS operating areas and land that will be designated and segregated for development of the SWPF.

ICD-08  (V-ESR-J-00008\textsuperscript{20}): This ICD describes the interface and tie-in between the SWPF Electrical Distribution System and the Infrastructure and Services Electrical Transmission System.

ICD-09  (V-ESR-J-00009\textsuperscript{21}): This ICD describes the interface between the SWPF and the SRS for vehicular roads, railroads, and perimeter fencing during the Construction and Operations phases of the SWPF Project. This includes general transportation logistics and specific construction and operations maintenance requirements.

ICD-10  (V-ESR-J-00010\textsuperscript{22}): This ICD describes the interface between the SWPF and Site LWO and M&O for WTL tie-ins and operations requirements. This includes SWPF waste feed from the Tank Farm, DSS feed to the SPF, and MST/sludge and strip effluent feed to the DWPF.

ICD-11  (V-ESR-J-00011\textsuperscript{23}): This ICD describes the interface between the SWPF and Site LWO and M&O for sampling and analysis, including characterization requirements for the macro-batches for SWPF feed and onsite/offsite analysis (if any) of SWPF in-process samples.

ICD-12  (V-ESR-J-00012\textsuperscript{24}): This ICD describes the interface between the SWPF Project and the Site LWO and M&O’s Emergency Response Organization (ERO). Other interfaces between the Site ERO (including Site Fire Department, Emergency Spill Recovery Team, Site Medical Department, Information and Technology Division, and Law Enforcement) are also described. The emergencies addressed by this ICD include occupational health and safety, environmental releases, security and safeguards breaches, transportation accidents, hazardous material spills, and fires.

ICD-13  (V-ESR-J-00013\textsuperscript{25}): This ICD describes the interface between the SWPF and SRS Site Communications Systems for interfacing facility Control Rooms (CRs), Site Emergency Response Operations functions, and Telecommunications and Control Datalink System (TCDS). These interfaces include telephone services, computer services, Distributed Control System (DCS) and Plant Information Network (PIN), red phone and ring down phone, Public Address System, radio communications, and fire alarms.
ICD-17 (V-ESR-J-0001726): This ICD describes the interface between the SWPF and the SRS Fire Protection Water Systems. The SWPF Fire Protection Water System will provide water for manual fire-fighting operations inside and outside the SWPF and for fire protection systems operations inside the SWPF.

ICD-18 (V-ESR-J-0001827): This ICD describes the interface requirements for work controls associated with the SWPF Project. During SWPF Construction activities, interfacing will be necessary to complete infrastructure tie-ins for utilities, waste transfer piping, and administrative activities. Interfaces will also be required for any work associated with the SWPF Project that lies inside or outside J-Area after establishment, or within S-Area prior to J-Area establishment.

ICD-19 (V-ESR-J-0001928): This ICD describes the interface between the SWPF and Site LWO and M&O for SWPF environmental permitting and monitoring activities. The functions, authorities, and responsibilities for acquiring necessary environmental permits, conducting environmental monitoring, and release reporting are specified in this ICD for Construction and Operation of the SWPF.

ICD-20 (V-ESR-J-0002029): This ICD describes the interface among the Site LWO and M&O, DOE-SR, and the EPC for the use or sharing of existing training resources. Three areas considered in this ICD are: (1) training EPC personnel, using Site M&O prepared training courses; (2) scheduling and tracking training, using the Site M&O Training, Records, and Information Network database and the EPC’s Training Records System; and (3) training Site M&O personnel, using EPC-prepared training courses.

ICD-21 (V-ESR-J-0002130): This ICD describes the interface among the SWPF and SRS onsite landfill and the offsite Three Rivers Municipal Landfill for non-radioactive solid waste (NRSW). This ICD specifies the functions, characterization, transportation, procedures, and administrative requirements associated with storage and disposal of NRSW, which will include construction waste, “Green is Clean” waste, Associated Waste, Special Waste, and consumable products generated by the SWPF.

ICD-22 (V-ESR-J-0002231): This ICD describes the interface among the EPC, DOE, and Site LWO and M&O Document Control systems.
ICD-23  
(V-ESR-J-00023³²):  
This ICD describes the interfaces and the respective responsibilities (including timelines) and information required to support integration of the financial data from the DOE, EPC, and Site LWO and M&O on the SWPF Project into the SWPF Monthly Report, which the EPC must prepare.

ICD-27  
(V-ESR-J-00027³³):  
This ICD describes the interface between the EPC and Site LWO and M&O for specifying the means and methods whereby EPC personnel are provided dosimetry and bioassay services from the Site LWO and M&O. The Site LWO and M&O maintain dosimetry records in accordance with applicable sections of Subpart H of 10 Code of Federal Regulations (CFR) 835, Occupational Radiation Protection: Records⁵⁷ and provides dosimetry reports to individuals and DOE, in accordance with 10 CFR 835, Subpart I (Reports to Individuals). Bioassay services include both whole body counting and supplied bioassay samples for the determination of intake and subsequent dose assessment.

Where interface requirements are not addressed by a particular ICD document and involve work by others, a Memorandum of Agreement will be created. This document will be in effect throughout the SWPF Contract³ and defines and integrates the roles and responsibilities for each Prime Contractor to ensure that work is performed safely and in compliance with applicable laws, regulations, and DOE requirements.

In addition to the ICDs identified above, other ICDs may be required for SWPF Construction, Commissioning, and Operations. The additional Site support services that may be required include procurement and warehousing of spare parts, sharing of maintenance craft resources for outages, and specialized technical assistance for long-term operation. The need for these ICDs and others will be identified during Construction, after the Commissioning Plan, O&M Staffing Plan, and other planning documents have been completed.

8.0 ARCHITECTURAL DESIGN

The SWPF consists of several structures. These structures include the Process Building, Administration Building, Diesel Generator (D/G), Compressor Building, Exhaust Stack, and miscellaneous equipment foundation pads (i.e., transformers, chillers, etc.). The Process Building is divided into four functional areas: the Central Processing Area (CPA), Cold Chemicals Area (CCA), Alpha Finishing Facility (AFF) and the Facility Support Area (FSA), which is further subdivided into the Northern Facility Support Area (NFSA) and Eastern Facility Support Area (EFSA). The Administration Building, and Compressor Building are separate structures, located in proximity to the Process Building. The Exhaust Stack, located on the east side of the Process Building, discharges high-efficiency particulate air (HEPA) filtered air from the CPA and AFF to the atmosphere. The D/G is an all-weather, enclosed package unit that will be located on a concrete pad to the northwest of the Process Building. A separate concrete pad will be provided for the bulk diesel fuel tank.
The CPA contains process equipment (e.g., vessels and interconnecting piping, pumps, valves, CSSX contactors, filters, coalescers, etc.) for the Alpha Strike Process (ASP) and the CSSX process. The CPA also contains operational control areas (i.e., CR, Safe Shutdown Panel [SSP] Room, Information Technology [IT] Server Room, and Uninterruptible Power Supply [UPS] Room), Waste Transfer Enclosure (WTE), Back-up Air Storage Room, Decontamination Area, Contactor Rebuild Area, Waste Storage area, Operating Deck, Analytical Laboratory, and Ventilation Equipment Rooms (i.e., cell inlet HEPA filters, building exhaust HEPA filters and fans, Analytical Laboratory exhaust systems, Process Vessel Ventilation System [PVVS] and Pulse Mixer Ventilation System [PMVS]).

The CCA houses the water and chemical handling systems that receive, store, and mix the required chemicals and extraction solvents for the SWPF processes.

The FSA houses the various process/plant support systems (e.g., HVAC, PW, Electrical Distribution, etc.) and O&M support areas (e.g., Maintenance Areas, Truck Bay/Dock, Radiological Support Areas, and other miscellaneous support areas).

The AFF contains process equipment to support an additional treatment of the CSSX effluent, if required.

All radiological materials used in the SWPF are located in the CPA or AFF. These buildings are engineered to perform waste treatment operations and confine/contain liquid and airborne contaminants.

8.1 Process Building

The Process Building consists of a central multi-level concrete structure with single-level braced frame steel structures surrounding the central concrete structure on the north, south, and east sides to contain the required process, utility, and maintenance functions. The central concrete structure is referred to as the CPA; the steel structures that house process/plant support functions consist of the AFF, CCA, NFSA, and EFSA.

The CPA is designed to provide radiation shielding and structural integrity for the ASP and CSSX process, which pose the greatest radiological dose and contamination hazard. The AFF poses a radiological contamination hazard, but the radiation dose hazard is low with removal of the $^{137}$Cs from the waste stream by the CSSX process. The radiological processing areas are segregated from the maintenance and support areas to confine the radiological hazards and restrict access to these areas.

A WTE contains automated isolation valves to control the transfer of waste feed to SWPF and the transfer of discharges to the DWPF. The Process Cells contain the process vessels that store and process high-activity wastes. The interconnecting piping, isolation valves, and waste transfer pumps that serve the Process Cells are primarily located in the North and South ASP Pump and Valve Galleries (P&VGs) adjacent to the Process Cells. Pumps in the North and
South ASP P&VGs are configured in labyrinth arrangements. The SSP Room and Back-up Air Storage Room are readily accessible from the outside of the Process Building.

The CR, IT Server Room, UPS Room, and Shift Supervisor’s Office are located within the CPA portion of the Process Building. This area is designed to meet tornado shelter requirements.

Primary access to the Process Building is through the EFSA. A covered entrance provides weather protection to persons entering or exiting the building. A Radiological Control Support Area is used for Radiological Control administrative functions and to provide a convenient access control point for entry into the Radiological Controlled Area of the Process Building. A Health Physics (HP) Ready Room, HP Count Area, HP Office, and the Personnel Decon Room comprise the Radiological Control Support Area. The EFSA also provides offices and work spaces for administrative functions.

Office areas in the EFSA include a DOE Office, Work Release Office, and offices for Supervisors, Maintenance, and Operations Managers. The NFSA houses the Mechanical Room, Electrical Room, Break Room (where meetings can be held), and Men’s and Women’s Toilets/Locker Rooms, additional offices, and miscellaneous non-rad storage rooms.

The maintenance support area includes Material Staging and Storage Area, a Drum Off/Decon Area, Waste Storage Area #1 and Contactor Rebuild Area located within the CPA. Other maintenance support areas are located in the EFSA and include the Truck Bay and Dock, Waste Storage Room #3, General Maintenance Shop, Mechanical Maintenance Shop (with foreman’s office), Electrical Maintenance Shop (with foreman’s office), Instrument Calibration Shop, Instrument and Control Equipment Maintenance Shop, and Fire Protection Valve Room.

The CCA contains tanks for receiving, storing, and mixing cold chemicals used in SWPF process operations. The CCA has a small non-rad laboratory and dedicated electrical and mechanical rooms. The area also contains an Operator Station and a unisex toilet.

An HVAC shielded chase is provided to provide radiation shielding for Process Cell inlet and exhaust duct penetrations. An area for clean HEPA filter storage and a staging area for HEPA filters for maintenance are located to the east of the Fan Room. The South Utility Chase along the north and east sides of the CSSX Contactor Support Floor is provided to facilitate routing of Cold Chemicals, Sample, Process Vent, and utility piping and HVAC ducts to various process and support areas. A Filter Drop Area is provided for equipment movement between floors. This drop area has a fire-rated cover. A CSSX Contactor Staging Area and the Contactor Variable-Frequency Drive (VFD) Room is provided. A CSSX Contactor Drop Area is provided to move contactor equipment between floors. This drop area has a fire-rated cover.
The SWPF includes:

- Heavily shielded unoccupied areas that provide confinement for radioactive liquid waste processing and storage, and
- Occupied areas for operations, maintenance, radiological control, and administrative activities.

Radiological controls are maintained in the Process Building by Radiological Buffer Areas (RBAs). The RBAs are established to prevent the spread of contamination from personnel/equipment/tools into uncontrolled areas of the building. The RBAs are provided with personnel/equipment contamination monitoring stations and step-off pads for removal of anti-contamination clothing.

8.1.1 Occupancy and Life Safety Code Analysis

The SWPF is designed to meet the requirements of American National Standards Institute (ANSI)/National Fire Protection Association (NFPA) 101, Life Safety Code; and IBC-2003, International Building Code. Facilities will provide access for the physically handicapped and comply with ANSI 117.1 2003, Accessible and Usable Buildings and Facilities except those used in the storage and processing of nuclear waste and where activities are deemed to be unsafe or unsuitable for the physically handicapped. Exempted facilities include, but may not be limited to, the following:

- Central Processing Area
- Actinide Finishing Facility
- Cold Chemical Area
- North Facility Support Area
- East Facility Support Area
- Compressor Building
- D/G Enclosure and Switchgear Area
- Liquid Argon Tank Area
- CCA Truck Unloading Area
- Northern / Southern Electrical Switchgear Area
- Chiller Pad Area

8.1.2 Occupancy Loads

The Process Cells, CSSX Tank Cells, CSSX Contactor Operating Deck, WTE, Pump and Valve Labyrinths, and utility (e.g., HVAC duct and piping) chases are normally non-occupied areas per
IBC-2003 requirements. The other portions of the SWPF Process Building, Compressor Building, and Administration Building shall be designed for the occupancy standards per IBC-2003, Table 1004.1.2.

8.1.3 Egress Requirements

Egress requirements specified in IBC-2003 (Chapter 10: “Means of Egress”) apply to each portion of the Process Building, Compressor Building, and Administration Building.

8.2 Central Processing Area

The CPA is designed to isolate vessels and other components within thick concrete-walled Process Cells to provide radiation shielding. The Process Cells also provide secondary containment and ventilation confinement. The Process Cells are designed to be “dark cells” that are not intended to be entered after initiation of Hot Operations. Shielded covers and sleeves are provided through the Operating Deck concrete floor to access components requiring replacement. The ventilation system is designed to maintain air flow from the Operating Deck into the Process Cells to provide confinement of airborne contamination. All other components, vessels, and piping systems located within the Process Cells are designed for the Contract-specified design life of 40 years.

Pumps and other equipment requiring maintenance are located in adjacent labyrinths. The walls between labyrinths and the access corridor are designed to provide radiation shielding. The ventilation system is designed to maintain air flow from the access corridor into the labyrinth to provide confinement of airborne contamination. The process systems are designed to allow remote isolation, flushing, and draining of labyrinth components to allow personnel to perform contact-handled maintenance. Administrative controls and temporary measures will be implemented during maintenance activities, if required. Additional details regarding equipment flushing and maintenance are contained in Section 12.0.

Stairways in the corners of the CPA provide the primary means for personnel access and emergency egress. Exit stairs that comply with the requirements of IBC-2003, Section 1005, are located at northwest, northeast, and southwest corners of the CPA. These exit stairs provide protected egress directly to the outdoors or through an approved horizontal exit into a protected corridor with 2-hour fire barriers per IBC-2003, Chapter 10. The Stair located in the southeast corner of the CPA is classified as a communicating stair for worker convenience. Although the construction is similar to an exit stair, this Stair does not lead directly to a protected means of egress and is, therefore, not credited in the SWPF egress calculations. This Stair is not required for exiting and will be marked with “Not for Emergency Egress” signage. An Equipment Lift located at the east end of the CPA is used to transfer equipment and materials between floors.

Process Cells

The CPA is designed with six separate Process Cells that contain waste processing tanks, filters, and piping. Each cell is constructed of reinforced concrete for NPH protection and for gamma
shielding. The cell floor and bottom portions of the walls are provided with a stainless steel liner for waste containment. The height of the liner is designed to contain the design basis spill. The cells are equipped with spray nozzles that can be used to flush the cell liner.

The Operating Deck is located above the Process Cells. Each Process Cell is equipped with a personnel access opening through the Operating Deck. The personnel access openings are fitted with removable cover blocks to provide radiation shielding. It is planned that these access openings will be used only during Construction and Commissioning. The access openings will be sealed prior to Hot Operations and the Process Cells are designed to be maintained as “dark cells” for the operating life of the facility.

The Process Cells are designed to allow the insertion of portable Closed-circuit Television (CCTV) units with remote pan, tilt, and zoom control. The CCTV units will be used to remotely assess conditions within the cells when necessary. The CCTV units are designed to be inserted and removed from the Operating Deck through shielded covers.

Removable shield covers are also positioned in the Operating Deck floor to allow replacement of tubesheet assemblies from the cross-flow filters (CFFs) located within the Alpha Sorption Drain Tank (ASDT) and SSRT/WWHT Cells. Valves and instrumentation located within the Process Cells are also designed to be remotely removed from the Operating Deck. Additional material handling details are provided in Section 12.0.

If access into a Process Cell is required, the personnel access block could be removed. Prior to removing the access cover, the Process Cell would be de-inventoried by emptying and flushing the vessel, piping, and/or cell liner to reduce radiation fields and associated radiological hazards. Manned entry would be permitted only under strict controls that would be specified in a Radiological Work Permit. The cell openings could also be used for final decommissioning and decontamination (D&D) of the facility.

8.2.1 Waste Transfer Enclosure

The WTE is located on the west end of the Process Cells. The WTE is depressed below grade to allow the underground WTLs to enter into the Process Building. The WTLs routed through the WTE include SWPF feed from the Tank Farm, MST/sludge to the LPPP, strip effluent to DWPF, and a spare.

The WTE is designed as a “dark cell” which is not planned to be accessed after initiation of Hot Operations. The WTE contains actuated isolation valves to control inter-facility transfers. The valves are sleeved to allow removal and maintenance to be performed from the above Waste Transfer Access Room without breaching WTE confinement. The penetrations are designed to provide radiation shielding to allow occupancy of the Waste Transfer Access Room during transfers. The WTE has a stainless steel liner pan with a sump that can be emptied by a remote pump located in the North ASP P&VG.
If access into the WTE is required, a single personnel opening through the floor of the Waste Transfer Access Room is provided. The opening will have a concrete plug that can be removed by using the overhead handling equipment. The Waste Transfer Access Room will be accessible from an outdoor access stair/platform. A temporary containment enclosure may need to be erected to allow entry into the WTE, should airborne radiological contaminants be present.

8.2.2 ASP North and South Pump and Valve Galleries

The North ASP P&VG, located adjacent to and on the north side of the Process Cells, contains pumps, valves, instrumentation, and piping system for the ASP. The P&VG area consists of several labyrinths. Each labyrinth houses the transfer pump and its related appurtenances, adjacent to or in close proximity to the vessel it serves. The labyrinth walls and other shielding features (e.g., doors) are sized to provide adequate shielding for maintenance/operations to be performed in an adjoining labyrinth. Temporary shielding (if required) will be used to supplement the fixed labyrinth walls/shielding devices. Each labyrinth is equipped with overhead lifting equipment to facilitate equipment removal/installation and to support general maintenance. Primary access is provided via a corridor on the north side from the Controlled Entry Area. Emergency-only egress is provided through an Emergency Exit Only (EEO) door at the west end of the corridor. Access into individual labyrinths is controlled by locked gates/doors. Entry into a labyrinth will be strictly controlled and monitored with appropriate lockout/tagout of electrical systems for pumps and valves for process and utility services.

The South ASP P&VG is adjacent to and south of the Process Cells. Primary access is provided via the South ASP P&VG corridor from an airlock at the east end. The airlock provides isolation between the CPA and AFF.

The ASP P&VG overhead lifting equipment and hand carts are used to move pumps and valves or other heavy equipment in or out of the ASP P&VG. Prior to performing maintenance, the waste transfer pathway containing the affected component is flushed and drained to allow direct contact-handled maintenance inside the labyrinth enclosure.

8.2.3 CSSX Tank Cells

The CSSX Tank Cell is located to the south of the CSSX P&VG to house vessels associated with the CSSX process. The vessels are arranged to facilitate pipe routing and penetrations between the vessels and their respective pumps. The CSSX Tank Cell is divided into an East and West CSSX Tank Cell. Each cell is constructed with reinforced concrete floors, walls, and ceiling to provide radiation shielding and maintain confinement of the waste (DSS and strip effluent) within the cells. The cell floors in the CSSX Tank Cells are provided with a stainless steel liner to provide containment for a design basis spill.

The East CSSX Tank Cell contains vessels that support the strip contactor operations. These vessels include the Strip Effluent Coalescer, Strip Effluent Stilling Tank, Strip Effluent Pump Tank, and Solvent Strip Feed Tank. Although the capacity of these vessels is small, the strip effluent contains concentrated $^{137}$Cs and will, therefore, emit high gamma radiation fields. All
vessels located in the East CSSX Tank Cell are designed for a 40-year operating life. A personnel access hatch is provided to allow access into the East CSSX Tank Cell, should an unplanned event occur.

The West CSSX Tank Cell contains vessels that handle the DSS waste stream, caustic wash, and solvent feed to the extraction contactors. These vessels include the Solvent Hold Tank, Caustic Wash Tank, Barium (Ba)-137 Decay Tank, and DSS Stilling Tank. Although these vessels emit high gamma radiation fields while the CSSX process is operating, due to the presence of $^{137m}$Ba (the daughter product of $^{137}$Cs), the radiation field in the West CSSX Tank Cell will quickly drop upon shutdown of the CSSX process due to short half-life of $^{137m}$Ba. Unlike the East CSSX Tank Cell, the West CSSX Tank Cell can be entered when the CSSX process is shut down. An airlock is provided on the west end of the cell to allow access from the CSSX P&VG corridor. Access is provided to allow replacement of the coalescer media from the Strip Effluent Coalescer, which protrudes through the shielding wall between the East and West CSSX Tank Cells.

8.2.4 CSSX Pump and Valve Gallery

The CSSX P&VG contains the pumps, valves, and instrumentation to route waste into and out of the CSSX equipment. The CSSX labyrinth design is similar to the ASP, with remote isolation, flushing, and draining capabilities. Overhead lifting equipment is also provided to facilitate maintenance and equipment removal. Access to the CSSX labyrinth is from the central CSSX P&VG Corridor. Access to individual labyrinths is strictly controlled, with locked gates/doors and administrative controls during maintenance.

The CSSX pumps, piping systems, and their associated labyrinths are typically smaller than the ASP labyrinths. However, the radiation field emitted from strip effluent process systems is generally higher than the ASP process systems. As such, additional radiation shielding is required to be provided in certain areas of the CSSX P&VG to maintain acceptable dose rates in the corridor during CSSX operations. The inventory of radioactive materials and piping surface area within individual labyrinths is also minimized to reduce the radiation fields.

8.2.5 Sample Pump and Valve Labyrinth

Samples are taken from various ASP and CSSX vessels to assess process effectiveness and provide characterization information to determine subsequent management of the waste. The sample pumps are located within a dedicated labyrinth. This labyrinth is accessible through the CSSX P&VG corridor.

8.2.6 Control Room

The CR is located on the north side of the Process Cells, west of the North ASP P&VG. The area is designed with dedicated consoles for Operators to monitor and control process, utility, and support systems. Critical CR support systems, including the UPS and IT servers, are located in rooms that are accessible through the CR. An office is also provided for the Shift Supervisor
who oversees the operations conducted within this area. Toilet facilities are provided so that Operators will not have to leave the area. The CR Access Area is provided adjacent to the Shift Supervisor’s Office, in order to monitor and control access into the CR. The CR also serves as a tornado shelter area.

8.2.7 Drum Off/Decon Area

The Drum Off/Decon Area is at the east end of the South ASP P&VG. The Drum Off Station is designed to transfer non-routinely-generated waste (e.g., off-specification materials, spill residues, decontamination fluids, cleaning solutions, degraded solvent, and laboratory waste) that cannot be recycled into the SWPF process. Under normal operations, wastes processed through the Drum Off Station are expected to be contact-handled. If the waste to be drummed emits a high radiation field, a shielded drum (e.g., 30- or 55-gallon drum inside a 55- or 85-gallon overpack drum with the annular space filled with a shielding material [steel shot or concrete]) will be used. Filling of drums will be manually performed, one at a time. Filled drums will be transferred to a waste storage area for staging for subsequent offsite treatment and disposal. Onsite solidification capability is not included in the SWPF design.

In situ decontamination will be remotely performed, using the flush and drain systems prior to maintenance. The item will be packaged to prevent exposure and transferred to the Decon Area. Hot maintenance activities will be conducted within the southern end of the Decon Area (i.e., Hot Maintenance Area). An airlock separates the contaminated operations from the passageway area (Material, Staging, and Storage Areas). Connections for Plant Air, flush water, oxalic acid (H₂C₂O₄), nitric acid (HNO₃), caustic, electrical power, and building exhaust are provided to support decontamination. The Decon Area will include a monorail and manual chain hoist, and a portable A-frame hoist. Portable equipment, shielding, and containment enclosures would be used on an as-required basis to handle special decontamination needs. Administrative controls will be established as required.

The floor and walls of the Drum Off/Decon Area are provided with epoxy or equivalent chemical-resistant coating and a sump for collecting liquid from decontamination rinses. The Drum Off/Decon Area is provided with washdown capabilities and a sump to collect decontamination solutions. The sump is equipped with a pump to transfer the decontamination liquids to the Decontaminated Salt Solution Hold Tank (DSSHT), Truck Bay, ASDT, or Drum Off Station. The Drum Off/Decon Area also includes a CCTV unit and radiation monitoring equipment.

8.2.8 Material Staging and Storage Area

The Material Staging and Storage Area is used for simple decontamination (e.g., surface wipe downs) or repair/maintenance of equipment. This area provides convenient access to the Truck Bay through an Equipment Corridor to permit removal of failed equipment or to receive/stage new equipment for installation. Material movement in this area is provided by a utility cart or Cask Transporter. The Material Staging and Storage Area serves as the radiological buffer zone...
for the movement of equipment into and out of the Radiological Controlled Area boundary. If required, temporary controls and airlocks will be established to facilitate transfer of equipment and material between the Material Staging and Storage Area and Equipment Corridor.

The Maintenance Cask, which provides shielding and containment for the CFF tubesheet assembly from the Process Cells, will be stored offsite. The Maintenance Cask uses a dedicated vertical area of the Process Building to allow transfer of items from the Operating Deck to the Material Staging and Storage Area or to the Drum Off/Decon Area for decontamination. When a Maintenance Cask contains a failed filter tubesheet assembly or other contaminated equipment, it will remain in the Material Staging and Storage Area awaiting transfer to a truck for transport out of the Process Building.

8.2.9 CSSX Contactor Support Floor and Contactor Operating Deck

The CSSX Contactor Support Floor and Contactor Operating Deck contain 36 contactors used to remove and concentrate $^{137}\text{Cs}$ from the waste stream. The contactors are supported from an elevated concrete slab. An intermediate grating floor is provided as the primary access into the contactor area from the CSSX Tank Cell Operating Deck. The Contactor Operating Deck and associated support floor are classified as non-occupied in the Code occupancy calculation because entry into this area cannot occur during operations, due to high gamma radiation fields. During operations, access to the Contactor Operating Deck is controlled by a lockable door. Air flow is from the CSSX Tank Cell Operating Deck into the Contactor Operating Deck and exhausted through the underlying Contactor Support Floor to preclude release of airborne radiological contaminants into normally occupied areas of the Process Building.

The contactor bowl assemblies and interconnected piping reside below the Contactor Operating Deck. The contactor motors, instrumentation, and electrical connections are located above the Contactor Operating Deck to allow maintenance access. The motors and contactor internal assemblies (e.g., rotors and bearings) are designed to be removed from the Contactor Operating Deck. Overhead lifting equipment is provided above the contactors to facilitate component removal and repairs.

Prior to performing contactor maintenance, the contactors must be de-inventoried. The de-inventorying process will normally be accomplished by operating the CSSX process with DSS as the aqueous feed. Because the DSS does not contain significant amounts of $^{137}\text{Cs}$, the inventory of $^{137}\text{Cs}$ within the CSSX contactors and associate process vessels is vacated. Additional internal contactor surface cleaning and/or decontamination can be accomplished while the contactors are operating with the clean-in-place (CIP) system. The contactors are also provided with drain valves that are accessible from the CSSX Tank Cell Operating Deck to allow appropriate contactors to be emptied. After the contactors have been de-inventoried, manned entry onto the Contactor Operating Deck is allowed for contact-handled maintenance under strict administrative controls. Failed contactor motors or internal assemblies can be transferred to the Drum Off/Decon Area for additional decontamination, repair, or packaging for disposal.
The contactor bowls, stands, and piping located below the Contacto Operating Deck are designed for the life of the plant. In the event of an unplanned leak or breakage, the contactors and piping systems will be drained and flushed to allow manned entry into the Contacto Support Floor. The grating will be installed in removable sections to allow access below the Contacto Operating Deck.

New or refurbished contactor components are kept as ready spares in the Spare Contactor Storage Area, east of Contactor Operating Deck. The Spare Contactor Storage Area also serves as the staging area for transferring contactors through the Contacto Drop Area to Elevation 100’-0”. Also located in this area is the DSS Coalescer to allow gravity drainage to the DSSHT, Intermediate Storage Tank (IST), or Alpha Sorption Tank-B (AST-B).

8.2.10 Process Building Exhaust HEPA Filter Room and Exhaust Fan Room

The Exhaust HEPA Filter and Exhaust Fan Rooms are located above the North ASP P&VG. These rooms contain the filtration trains that filter exhaust air from Process Cells prior to discharge to the Exhaust Stack. Primary access into these rooms is from the east end via Stair #2NE. An EEO door into Stair #1NW is provided at the west end of the Exhaust HEPA Filter Room. Portable lifting equipment will be used to gain access for changing of HEPA filters. The spent filters will be bagged as they are removed from the filter housing and transported by hand carts, using the Equipment Lift. A Clean HEPA Filter Storage Area is located between the Exhaust Fan Room and Stair #2NE to provide convenient local storage.

8.2.11 Other Miscellaneous Areas

The SSP Room is a dedicated room on the west side of the CR. The SSP Room is normally unoccupied and provides back-up process control and shutdown if the primary control system fails or the CR becomes uninhabitable or inaccessible. Sufficient equipment and a remote computer connection node with an Operator workstation are provided to either shut down operations or maintain the process in a safe quiescent state, such that no loss of equipment or product occurs. Access into the SSP Room is from the outside through an administratively controlled and secure door.

Under normal operations, process vessels are actively purged with air from the Plant Air System and exhausted by the PVVS to remove flammable gases from the vessel head space. An on-line, back-up Air Dilution System (ADS) is provided to maintain the flow of purge air if General Service (GS)/PC-1 Plant Air supply is interrupted. The ADS and associated purge air system are classified as Safety Significant (SS) and are required to remain operational after a PC-3 NPH event. To ensure continued operation, a four-day supply of compressed air will be maintained within the confines of the PC-3 concrete structure in the Back-up Air Storage Room. The Back-up Air Storage Room is accessed from outside to provide easy access for maintenance.
8.2.12 Operating Deck

The Operating Deck is located above the Process Cells and is designed as an open high-bay area (approximately 37 ft) to allow maintenance, including replacement of CFF tubesheet assemblies. The failed tubesheet assembly is placed into a shielded transport cask that is then lowered down to the Material Staging and Storage Area by an overhead bridge crane. The transport cask is designed to contain radioactive liquids or loose surface contamination during handling. Additional details are provided in Section 12.0.

The Operating Deck bridge crane is sized and designed to remotely handle the shielded transport cask. The bridge crane will also be used for other maintenance activities (e.g., removal/replacement of extended valve internals) and can be used to remove the personnel access covers. The crane can be controlled locally by a radio frequency control system or remotely operated from the CR. The crane also has a camera with pan, tilt, and zoom capabilities. In event of failure, the bridge crane can be returned to the eastern crane maintenance area by using a retrieval system.

Utility services are routed through the Operating Deck and penetrate the floor to connect to process systems. These services include Plant Air, process chilled water (PCHW), process and flush water, and cold chemicals. Plant Air is used to operate the Air Pulse Agitators (APAs), back-pulse CFFs, provide dilution air to purge vessel head space, and supply instrument air to bubblers. PCHW is distributed to tank cooling jackets and heat exchangers to maintain process operating temperature. PW is used to adjust waste chemistry, and flush water is provided to clean piping systems, equipment, and cell liners. Cold chemicals to the Process Cells include caustic, H₂C₂O₄, HNO₃, and MST.

Valves, instruments, and distribution piping used to control the supply of these services to the Process Cells are located on the Operating Deck. Valves for the APAs and filter back-pulsing are located within enclosures (e.g., Pulse Mixer Enclosures A, B, and C, and Filter Vent Relief and Blowdown Enclosure). The enclosures are sized to provide shielding for radiation shine from the Process Cells and to guard against potential contamination, should back-flow of process waste occur. The enclosures are also designed to allow access for valve maintenance.

The Operating Deck also allows access to valves, instrumentation, and CCTV units that are located in the Process Cells. Shielded sleeved penetrations through the Operating Deck floor are provided to remove and replace valve internals, instruments, and cameras without entering into the Process Cell by contact- or remote-handled methods, depending on the dose rate encountered. For components expected to contain liquid or loose surface radioactive material, flexible bagging or a shielded steel container will be placed over the opening and the component will be retracted into the bag/container. The bag/container will be sealed and prepared for transfer to the Material Staging and Storage Area or the Drum Off/Decon Area via the Equipment Lift or the ASP Filter Cask Drop zone.
8.2.13 Cell Inlet Air HEPA Filter Rooms

The ventilation system is designed to cascade air flow from non-contaminated normally occupied areas to the inaccessible potentially contaminated Process and CSSX Tank Cells. HEPA filters are located on the Process and CSSX Tank Cell inlet ductwork to guard against radioactive particulate contamination migration into normally occupied areas, should an air flow reversal or loss of exhaust ventilation occur.

Cell Inlet Air HEPA Filter Room #1 is located, above the Process Building Exhaust HEPA Filter Room, and contains a separate single-stage inlet HEPA filter for each Process Cell, except the FFT-A Cell. This area is accessible from the east through the PVVS/PMVS and Laboratory Vent Room. An emergency egress door into Stair #1NW is located on the west end of Cell Inlet Air HEPA Filter Room #1.

Cell Inlet Air HEPA Filter Room #2 is located on the east side of the CSSX Contactor Support Floor and contains separate single-stage inlet HEPA filters for the FFT-A Cell and CSSX Tank Cells. Access to Cell Inlet Air HEPA Filter Room #2 is provided via Stair #3SE through the CSSX Contactor Drop Area.

8.2.14 PVVS/PMVS and Laboratory Vent Room

The PVVS/PMVS and Laboratory Vent Room contains equipment to treat and filter air from process equipment and the Analytical Laboratory radio hoods (including room exhaust). The ceilings, walls, and floors are constructed of concrete. Access to the room is provided via PVVS/PMVS HEPA Filter Staging Area and Stair #2NE located at the east end. An EEO door is provided at Stair #1NW for emergency egress through Cell Inlet Air HEPA Filter Room #1. Additional design details for the ventilation systems are provided in Section 14.0.

8.2.15 Analytical Laboratory

The Analytical Laboratory is located south of the Operating Deck, above the CSSX Area and Cell Inlet Air HEPA Filter Room #2. The laboratory is designed to analyze samples taken from individual vessels to determine process performance and characterize waste feeds and products to ensure compliance with facility WAC. The laboratory will be outfitted with a variety of instruments to provide full-service capabilities for inorganic, organic, and radiochemical analyses. External (SRS or offsite) laboratories may be used to supplement SWPF laboratory capabilities.

Samples from the Process Cells and CSSX Tank Cells are pumped to the shielded Hot Cell for sample preparation and dilution to allow subsequent contact-handling of the sample aliquots. Samples from AFF are pumped directly to Gloveboxes for sample preparation because the AFF samples do not emit high gamma radiation fields. The aliquots will be transferred to gloveboxes and radio hoods for analyses. The analytical instruments will be located in gloveboxes and radio hoods to provide containment of the radiological samples and preclude airborne contamination, should a spill occur.
Samples from the Tank Farm will be periodically received and analyzed in the SWPF Analytical Laboratory. These samples will be transferred to the EFSA Truck Bay in a shielded container. The shielded container will be transferred to the Analytical Laboratory, using the Equipment Lift. The sample shielded container is then transferred into the Hot Cell and opened to remove the sample for analysis preparation.

Primary access to the laboratory is provided via Stair #3SE located in the southeast corner of the CPA. The Analytical Laboratory floor and bottom portions of the walls will be installed with a material to allow decontamination. Laboratory design includes safety cabinets, ventilation controls, and monitors to protect against radiation and chemical exposure, fire, and asphyxiation associated with handling samples, analytical reagents, combustible materials, and inert gases.

The laboratory is also equipped with benches, sinks, and safety shower/eyewash stations. Drains from the Hot Cell and gloveboxes are routed to the Laboratory Drain Tank. A dedicated drain to the Solvent Drain Tank (SDT) is also located in the Hot Cell to allow excess sample containing solvent to be returned to the process. This drain will be elevated above the Hot Cell liner and covered when not in use to ensure that other liquid wastes are not inadvertently drained to the SDT. Drains from laboratory radio hoods and bench sinks are directed to the Lab Collection Tanks. Solid wastes from the Hot Cell and gloveboxes are bagged or placed into a disposal drum and transferred to an offsite waste disposal facility.

8.3 Facility Support Area

The FSA houses the Mechanical and Electrical Rooms, Break Room, Toilets, administrative offices, HP Support Area, Equipment Corridor, Truck Bay/Dock, and Maintenance Shops. The FSA is designed as two separate, de-coupled steel-frame/panel structures. The two structures are designated as the NFSA and EFSA.

The main entrance into the Process Building is located in the northeastern portion of the FSA. The entry corridor connects to the main NFSA personnel corridor that extends in an east-west direction on the north side of the CPA. The entry and NFSA corridor provide the major access to the Radiological Controlled Area Boundary. They also provide access to a majority of the Process Building areas including the mechanical/electrical rooms, CR, toilets/lockers/showers, Break Room, administrative offices, CPA, and HP areas.

A secondary personnel corridor (EFSA corridor) extends in a north-south direction from the main NFSA corridor to the Maintenance Shops. This corridor is located adjacent to the Truck Bay/Dock for egress and access to the Dock and Equipment Corridor. A larger Equipment Corridor is provided between the Truck Bay/Dock and the CPA to allow movement of equipment and materials into and out of the CPA. This corridor will also need to accept spent filters from the AFF through the Mechanical Maintenance Shop.
8.3.1 Electrical Room

The Electrical Room is located in the northwest portion of the Process Building. The Electrical Room contains switch gear, motor control centers (MCCs), and distribution panels for the majority of the CPA and FSA loads, including the Compressor Building and chiller units. The Electrical Room also contains automatic transfer switches (ATSs) for standby D/G (SDG) operation. A separate Fire Protection Valve Room is located in the southwest corner of the Electrical Room and is accessible from the outside of the building.

8.3.2 Mechanical Room

The Mechanical Room is located to the east of the Electrical Room and houses the air handling units (AHUs) for the CPA, FSA, and CR. This room also contains pumps and tanks for operation of the chilled water and heat recovery systems. Separate chilled water systems (CHWSs) are provided for building air supply, CR air supply, and process cooling.

8.3.3 Break Room

The employee Break Room is located to the east of the Mechanical Room. The Break Room will be furnished with chairs, tables, and kitchen appliances for employees to assemble during shift changes and to eat their meals. It is located outside the Controlled Area Boundary.

8.3.4 Locker and Shower Area

Men’s and women’s toilets, lockers, and showers are located to the east of the Break Room. The locker area will be used by employees to change from personal clothing into SWPF work clothing. Upon shift completion, employees can shower before leaving.

8.3.5 Administrative Offices

A number of offices are provided in the FSA for managers, engineers, and DOE representatives. These offices supplement other offices located in the Administration Building and distributed throughout the Process Building. Space for radiological control support functions is also located in this portion of the FSA. The support area includes an HP Office, an HP Count Area, a Personnel Decontamination Room, and an HP Ready Room.

8.3.6 Truck Bay/Dock

The Truck Bay/Dock is located at the northeast corner of the Process Building and provides direct access to the Equipment Corridor and General Maintenance Shops Area for loading materials and equipment. Solid wastes, including LLW, can also be loaded onto trucks for transport to the SRS LLW disposal facilities. Sample shielded containers with samples from the Tank Farm will also be received in the Truck Bay for analysis at the SWPF Analytical Laboratory. The Truck Bay is sloped toward a trench covered with metal grating to collect...
rainwater or spills. The trench will serve as a sump and will be sampled; it can also be pumped to carboys or similar containers for disposal as required.

8.3.7 Maintenance Shops

The Maintenance Shops are located on the east end of the Process Building in the EFSA. The General Maintenance Shop contains Clean Tool Storage and Waste Storage Room #3, and is adjacent to the HP Rooms. The south wall is adjacent to the Equipment Corridor. The Equipment Corridor separates the General Maintenance Shop and the Electrical Maintenance Shop, Mechanical Maintenance Shop, and the Instrument Calibration Shop, and two Foreman Offices.

8.4 Cold Chemicals Area

The CCA is located on the southwest side of the Process Building and is bound on the north by the CSSX Tank Cells and on the east by a fire barrier wall that separates the CCA from the AFF. The exterior walls are insulated metal panels and the floor is concrete, finished with appropriate coatings to facilitate clean-up of a spill in the area.

The CCA houses material handling equipment, tanks, pumps, and piping systems for the receipt, preparation, storage, and distribution of process chemicals and water. The process chemicals are delivered to the CCA as bulk, concentrated materials. A receiving dock is provided on the West side of the CCA for unloading process chemicals delivered by either tank truck or in drums.

The delivered process chemicals include concentrated caustic solution (50 weight percent sodium hydroxide [NaOH]), 20 weight percent HNO₃, 0.5 Molar H₂C₂O₄ solution, drums of MST/slurry and Isopar®L, and other solvent components. The concentrated Nitric Acid Receipt Tank and Filter Cleaning Acid Feed Tank will be passively vented through the CCA roof to the atmosphere and will have a loop seal on the overflow to prevent acid fumes entering into the work space. All other tanks will be passively vented into the CCA. The caustic and acid will be mixed with water to achieve the desire concentrations to support process operations. Separate storage tanks are provided for the different solution concentrations. The storage tanks are grouped into five separate containment areas, based on chemical compatibility (i.e., HNO₃ area, neutralization area, caustic area, filter cleaning acid area, and solvent area). The containment areas are divided by concrete dikes sized to contain the design basis spill within the containment area and to isolate incompatible chemicals.

Systems for production and storage of the DI water are located within and adjacent to the CCA. Storage and distribution pumps for PW for flushing and process chemistry adjustment are also located in the CCA. The DI and PW tanks are not required to have containment dikes.

Solvent components including drums of Isopar®L (diluent), BobCalixC6 (extractant), Cs-7SB (modifier), and tri-n-octylamine (suppressant) will be stored within the CCA. Fire cabinets will be used for storage of the Isopar®L. Storage space is also provided in the CCA for an
approximately 9 day supply of MST in drums with additional storage provided in the SWPF warehouse for a total of a three month supply.

The CCA has a small laboratory area to the east of the CCA Receiving Dock. The non-radiological CCA Laboratory is equipped with a wet chemistry laboratory bench to verify chemical quality upon receipt of bulk deliveries and periodic assessment of process chemicals in storage. The laboratory also has a lockable storage area to provide secure storage of high-value solvent components. Adjacent to the laboratory is a unisex restroom and shift Operator’s office.

The CCA also has dedicated Mechanical and Electrical Rooms. The CCA ventilation system is separate from the rest of the Process Building to maintain constant environmental conditions within the CCA to prevent chemical freezing/degradation and breathing of tanks. Because radiological controls are not required for the CCA, exhaust air is directly vented to the atmosphere through roof-mounted ventilators. Motor controls, power distribution panels, and instrument control panels (ICPs) for the CCA are located in the CCA Electrical Room.

8.5 Alpha Finishing Facility

The AFF houses the process vessels, Alpha Sorption Filters, and pumps and valves that provide the capability to perform a second or third MST strike. The AFF is located in the southeastern portion of the Process Building. The AFF receives DSS/Cs-depleted Clarified Salt Solution (CSS) from the CSSX process, which has only trace quantities of $^{137}$Cs and suspended solids and is depleted in soluble Sr and actinides.

The AFF contains adsorption and filtration process equipment similar to ASP to remove additional Sr and actinides, if required to meet SPF WAC. MST is added to the waste on a batch basis. Each batch is mixed for six hours to adsorb the actinides and Sr onto the MST. The resulting MST/sludge is filtered and concentrated. After processing seven batches, the concentrated MST/sludge is transferred back to the SSRT in the Process Building for sludge washing. The filtrate is directed to the DSSHT for subsequent transfer to the SPF.

The AFF process vessels are located within one of two individual diked tank areas. One dike area contains the IST, AST-B, and associated pumps. The second diked area contains the DSSHT, Filter Feed Tank-B (FFT-B), Cleaning Solution Dump Tank-B, MST/Sludge Transfer Tank, Alpha Finishing Process (AFP) CFFs, two laboratory waste collection tanks, and associated pumps. Each diked area is sloped to a sump. The containment dikes are designed to contain the design basis$^A$ spill and both diked areas are lined with a decontaminateable chemical resistant coating (e.g., epoxy), in compliance with NFPA and IBC code requirements for flame spread and smoke development. The dike walls are sized to contain the contents of the tanks in

$^A$ A design basis spill is the largest amount of liquid that could be reasonable collected in the spill containment area. It is typically the larger of 110% of the volume of the largest tank volume or the volume that could be collected via a transfer due to equipment failure (e.g., the contents of the Salt Solution Feed Tank can be collected in the Solvent Drain Tank Cell via piping failure in the Salt Solution Feed Pump Labyrinth and collection in the Salt Solution Feed Pump Labyrinth Sump.)
the respective areas. A third area is provided for the Alpha Finishing Drain Tank, which is depressed below the surrounding diked areas to allow gravity draining of process vessels, equipment, and pumps.

The process tanks, pumps, valves, and AFP filters are located within the AFF diked areas. An elevated platform along the north and south sides of the diked areas provide access to the process equipment. The elevated platform extends along the south side of the IST/AST-B dikes into the DSSHT/FFT-B area and along the north side of the DSSHT/FFT-B area. The two elevated platforms are connected by an elevated platform running north/south over the dike separating the IST/AST-B area from the DSSHT/FFT-B area. An overhead crane that spans all of the tank areas provides the capability for removing/replacing process equipment. Because of the very low Cs concentrations and radiation levels, the AFP equipment can be repaired or replaced by contact-handled maintenance methods.

Support areas consisting of the AFF Personnel Access/Airlock, Operator Room Electrical Room, Mechanical Room, HEPA Filter Room, and Exhaust Fan Pad are located to the south of the AFF Process Area. The AFF Personnel Access/Airlock provides a secondary entry/exit to the Radiological Controlled Area boundary. Personnel contamination monitoring will be conducted within this area prior to exiting the AFF. The AFF Operator Room provides a work area and record storage for AFF. The motor controls and power distribution for the AFF are fed from the southern transformer into the AFF Electrical Room.

The AFF is equipped with dedicated supply and exhaust ventilation equipment, including a single AHU and a single two-stage HEPA filtration trains and exhaust fans. The ventilation system is designed to maintain the AFF Process Area at a negative pressure with respect to atmosphere. Air flow is also cascaded from the support areas into the process area. The AFF exhaust fans are located outside on a concrete pad. The AFF filter air is discharged to the Exhaust Stack.

The AFF is a conventional steel-framed structure with insulated siding and a membrane roofing system. To preclude excessive air infiltration, an interior moisture-resistant gypsum-board wall system supported by metal studs will be provided. The gypsum board will be protected with decontaminatable finish (i.e., cleanable using traditional decontamination means, e.g., water followed by dilute caustic and acid, if needed). The AFF has a limited radioactive material inventory and poses minimal risk to onsite workers or the public. All process vessels, piping, and ductwork in the AFF are designated as PC-1. As such, the AFF is designed to meet PC-1 structural requirements. To prevent adverse interactions with PC-3 SSCs, the AFF is structurally decoupled from the CPA.

A radio-operated bridge crane will be used for filter and pump maintenance, removal, and replacement. Access for crane maintenance will be provided by a work platform located at the east end of the building.

The AFF also contains sample pumps for collecting samples from the process tanks. The samples will be pumped to a glovebox located in the Analytical Laboratory.
The AFF does not have any dedicated storage areas. Spent filters or other radioactive solid waste will be staged at the east end of the AFF, appropriately packaged, and transferred to Waste Storage Area #1 for interim storage prior to shipment offsite.

8.6 Administration Building

The Administration Building is a pre-engineered metal building. The structure includes a non-combustible membrane roofing system and wall panels, non-combustible gypsum wall partitions, acoustic ceiling tile, carpet with ceramic tile and/or sheet vinyl flooring (where required), aluminum ribbon-windows, and exterior metal doors and frames. The Administration Building, furnished with siding to match the surrounding structures, will have a single-slope roof to the south where the turn-key supplier will provide an underground header to tie into the new stormwater collection system. The building will be approximately 93 x 153 x 18 ft high and provides space for:

- Simulator Training Area;
- Multiple Conference Rooms with subdividing partitions;
- Operations Support Center;
- Lunch Room with kitchen;
- Document Control Room;
- Offices and cubicles for personnel;
- Reproduction/Copy Room;
- Records;
- Storage space;
- Men’s and women’s restrooms, including janitor closet;
- Mechanical, electrical, and telephone rooms; and
- Entry/waiting area at the main entrance.

The Administration Building will be equipped with a standard industrial HVAC system with variable air volume distribution. The building will be equipped with an automatic sprinkler system, fire alarms with pull stations, and multiple exits, as required by applicable NFPA codes. The building exterior will have pre-finished insulated panels that match the Process Building and surrounding SWPF structures.

8.7 Diesel Generator

The D/G will be used to provide standby power, as opposed to emergency power (i.e., back-up power is not safety related) and will be designated as a SDG. This type of generator is classified as an emergency diesel under SCDHEC regulations and approved in the SWPF permit, SWPF-
14-162, *SWPF SDG Operating Permit*\textsuperscript{61}. The terms D/G and SDG are used interchangeably within this BOD and corresponding design documents.

The unit will be within an all-weather enclosure that is built on a transportable skid frame. The D/G will come complete with main circuit breaker, day tank, batteries and charger, engine cooling fans, exhaust silencer, and generator controls. The D/G will be placed on a concrete pad. A separate concrete pad will be provided for the bulk double-wall fuel storage tank. Spill containment will be provided around filling, pumping, and dispensing areas. The D/G and associated components are designated GS/PC-1.

### 8.8 Compressor Building

The Compressor Building is a pre-engineered structure, designed for loads in compliance with PC-1 requirements. The sidewalls consist of insulated metal panels and the roof consists of thermoplastic membrane on rigid insulation on corrugated metal decking. Wall openings are provided for intake louvers and wall dampers. The roof has roof-mounted fans with dampers for active ventilation. The building includes space heaters. The building is provided with an overhead door and a personnel door. The building contains three air compressors. The Compressor Building, compressors, and associated components are designated GS/PC-1.

### 9.0 STRUCTURAL DESIGN

The SWPF consists of three detached buildings and several yard structures. The three buildings, in order of decreasing size, are SWPF Process Building, Administration Building, and Compressor Building. The four main yard structures are the Transformer Pad, Chiller Pad, D/G Pad, and Exhaust Stack. Additional subsidiary yard structures include concrete slabs adjacent to the CCA and Compressor Buildings, a transformer pad south of the AFF, concrete foundations for exhaust ductwork supports, utility (pipes, cable trays, and ducts) support structures west, east, and north of the CPA, and miscellaneous building pads and sidewalks for personnel. This Balance of Plant BOD presents design criteria applicable to all SWPF structures. Further detailed design and acceptance criteria for the SWPF Process Building can be found in P-ESR-J-00002, *SWPF Project Structural Acceptance Criteria*\textsuperscript{62}.

The Process Building consists of a central multi-level concrete structure and single-level braced-frame steel structures, which surround the central concrete structure on the north, south, and east sides. The central concrete structure is referred to as the CPA. The steel structures consist of three general functional areas: CCA, AFF, and FSA. The CCA and AFF are aligned side-by-side immediately south of the CPA. The FSA is structurally divided into Northern and Eastern portions, labeled NFSA and EFSA, respectively. As their names imply, the NFSA is immediately north and the EFSA is immediately east of the CPA. Figure 9-1 provides a plan view of the SWPF Process Building and shows the relative orientation of the CPA, CCA, AFF, NFSA, and EFSA. The Compressor Building is braced-frame steel structure on a concrete foundation. The D/G will consist of an all-weather, skid-mounted enclosure located on an outdoor concrete pad and an adjacent fuel storage tank on a separate concrete pad. The Administration Building will be a pre-engineered turn-key steel building on a slab foundation.
The SWPF SSCs shall be designed in accordance with the graded approach to NPH protection required by DOE O 420.1B, Facility Safety\textsuperscript{63} and implemented by DOE-STD-1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities\textsuperscript{64} and DOE-STD-1021-93, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components\textsuperscript{65}. DOE-STD-1021-93 shall be used to assign PCs to structures, based on the safety analysis of the facility. Once the PCs have been assigned, design criteria are derived from DOE-STD-1020-2002. Design criteria for major SWPF structures are documented in P-ESR-J-00002\textsuperscript{62}. PCs are used as a means to ensure a graded level of protection for the SSCs during NPH events. The SWPF Structural PC classifications range from PC-1 through PC-3, in order of increasingly stringent NPH mitigation and performance requirements. Section 9.1 provides a description of the process used for assignment of PCs to the SSCs.

Figure 9-1. SWPF Structural Design Areas (Elevation 100’-0”)}
9.1 Natural Phenomena Hazard Performance Categories

The assignment of a PC to a given SSC is based on the safety classification of the SSC established by the safety analysis. Performance objectives are used to establish appropriate design criteria (e.g., seismic acceleration level, maximum wind speed, flood elevation, etc.) for NPH mitigation. The rigorous design requirements are limited to those SSCs classified as Safety Class (SC) or SS, consistent with DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*.66

PCs are assigned in accordance with DOE-STD-1021-9365. Figure 9-2, reproduced from DOE-STD-1021-93, presents the methodology for PC designation of SSCs. SSCs that provide a safety function are designated as PC-1 through PC-4 in ascending level of importance, based on release consequences and life safety effects that could result from failure of an SSC. The requirements for PC designation are described below.

PC-4

An SSC is designated as PC-4 if it is an SC item as defined in DOE-STD-3009-9466 and if its failure during an NPH event could result in offsite release consequences greater than or equal to the unmitigated release from a large (> 200 megawatts thermal) Category A reactor severe accident. None of the SWPF SSCs are designated as SC and offsite radiological release consequences resulting from an NPH event are less than a Category A reactor severe accident as stipulated in DOE-STD-3009-94. Therefore, none of the SWPF SSCs are designated as PC-4.

PC-3

An SSC shall be designated as PC-3 if its failure during an NPH event could result in offsite release consequences greater than the Evaluation Guideline limits in Appendix A of DOE-STD-3009-9466, but less than those associated with PC-4 SSCs. The Exposure Guideline (EG) for the Maximally Exposed Offsite Individual (MOI) is 25 Roentgen Equivalent Man (rem) Total Effective Dose Equivalent (TEDE). Based on the results of S-SAR-J-0000111, there are no SSCs whose failure could result in an offsite dose consequence that would approach the 25-rem EG value. Although no SWPF SSCs require a PC-3 designation, according to current DOE Orders and Standards, the CPA is designated a PC-3 structure per direction received for Phase II SWPF Enhanced Preliminary Design (SPD-06-014, Modification No. M026 to Contract No. DE-AC09-02SR22210, Salt Waste Processing Facility (SWPF) Project, Direction to Begin Enhanced Preliminary Design (EPD) to Address Radiological Confinement Concerns Raised by the Defense Nuclear Facilities Safety Board (DNFSB)67.
SSC is a “safety class” item and its failure due to an NPH event would result in offsite radiological release consequences greater than or equal to the unmitigated release associated with a large (>200 MW) Category A reactor severe accident.

PC-4
(Not Applicable to SWPF)

PC-3
(Offsite radiological consequences for SWPF are less than DOE-STD-3009-94; however, the primary confinement boundary for certain systems and components was designated PC-3. CPA assigned PC-3 for purposes of II/I protection.)

PC-2
(Applicable to Waste Transfer Lines)

PC-1
(Applicable to all other SWPF Buildings and Yard Structures)

PC-0

---

a. SSC performs emergency functions to protect onsite workers from significant exposure to radioactive or toxic material release, or
b. SSC is part of a building used for assembly of more than 300 persons in one room, or
c. SSC has been classified as SS

---

a. SSC is a building/structure with potential human occupancy, or
b. SSC failure may cause fatality or serious injuries to in-facility workers, or
c. SSC failure can be prevented cost-effectively by NPH design.
PC-2

An SSC shall be designated as PC-2 if it is not covered in PC-4 and PC-3 criteria above, and if any of the following conditions apply:

1. The SSC’s failure by itself or in combination with one or more other SSCs may result in loss of function of any emergency handling, hazard recovery, fire suppression, emergency preparedness, communication, or power system that may be needed to preserve the health and safety of workers and visitors. This includes NPH-caused release of radioactive and toxic materials that would result in these consequences.

2. The SSC is part of a building that is primarily used for assembly of more than 300 persons (in one room), and the SSC failure may adversely affect the life safety of the occupants.

3. The SSC has been classified as SS. SS SSCs, as defined in DOE-STD-3009-94, are those SSCs that prevent significant exposure to onsite workers from a release of radioactive or hazardous materials, but are not required to prevent exceeding the EG (25 rem TEDE) for the MOI. SSCs required to prevent a release of hazardous materials that could result in exposures to onsite workers in excess of the Emergency Response Planning Guideline-3 level or 100 rem are designated as SS and are designed to meet PC-2 structural requirements (WSRC Manual E7, Conduct of Engineering and Technical Support, Procedure 2.25: Functional Classifications).

An SSC that does not satisfy the above criteria may also be placed in PC-2 from cost and mission considerations (e.g., when failure of an SSC would prevent the facility from performing its mission and repair or replacement could take a significant time period or would be very expensive).

S-SAR-J-00001 identifies several SSCs whose failure caused by an NPH event could result in a prompt fatality or serious life-threatening injury. Based on DOE-STD-3009-94, the preventive or mitigating controls for events that result in such consequences are required to be classified as SS. The majority of SS systems and components are located in the CPA portion of the Process Building, which has been designated PC-3. The AFF Building HVAC exhaust system are designated SS for non-NPH events.

PC-1

An SSC that is not covered in PC-4, PC-3, and/or PC-2 criteria shall be designated PC-1, if any of the following conditions apply:

1. It is a building/structure with potential human occupancy,

2. The SSC’s failure may cause a fatality or serious injuries to in-facility workers, and/or

3. The SSC’s failure may cause damage that can be prevented or reduced cost-effectively by designing it to withstand NPH effects.
The remaining SSCs not specifically identified in S-SAR-J-00001\textsuperscript{11} as having an SS functional classification are classified as GS and will be designed to meet the requirements for PC-1, unless evaluation of interaction effects requires an upgrade to a higher PC or the items have been designated PC-0 (e.g., plumbing and drain components). All final functional classifications for SSCs will be ultimately defined in the Documented Safety Analysis (DSA). Except for the core process areas of the Process Building and the areas above them, the peripheral areas of the Process Building are designated as PC-1. All PC-1 areas within the Process Building are designed to be independent structures to prevent the PC-1 structural elements from adversely affecting the PC-3 core structure during an NPH event. Other PC-1 structures include the Compressor Building, D/G, and Administration Building.

In addition to the requirements for protection of SSCs classified as SS, the SWPF Process Building layout provides for one or more safe rooms as tornado shelters. These safe rooms will follow the guidance presented in Federal Emergency Management Agency (FEMA) 361, *Design and Construction Guidance for Community Shelters*\textsuperscript{69}.

### 9.2 Natural Phenomena Hazard Performance Objectives

The NPH design objectives for each designated PC are based on criteria provided by DOE-STD-1020-2002\textsuperscript{64}. The PCs requiring NPH protection for the SWPF range from: PC-1 for SSCs that provide protection for life safety, through PC-2 for SSCs that preserve the health and safety of facility and onsite workers, to PC-3, which ensures that offsite dose consequences do not exceed the EGs in DOE-STD-3009-94\textsuperscript{66}. In applying the design/evaluation criteria of DOE-STD-1020-2002, design basis load levels are determined, based on the calculated methods and level of conservation specified for the applicable PC. For seismic design of PC-1 and PC-2 structures, DOE-STD-1020-2002 implements IBC-2003\textsuperscript{59} in its entirety. Seismic design of PC-3 structures follows the specific requirements of DOE-STD-1020-2002.

For each PC, annual hazard exceedance probabilities are used for determining the worst-case design loads for which the SSC will have to be evaluated. The hazard exceedance probabilities for the primary NPHs for which the SWPF will be analyzed (seismic and wind) are specified in DOE-STD-1020-2002\textsuperscript{64}. Table 9-1 provides a summary of NPH criteria for the SWPF.
Table 9-1. Natural Phenomena Hazard Criteria

<table>
<thead>
<tr>
<th>Performance Category</th>
<th>PC-1</th>
<th>PC-2</th>
<th>PC-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEISMIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Goal</td>
<td>1x10³</td>
<td>5x10⁴</td>
<td>1 x 10⁴</td>
</tr>
<tr>
<td>Annual Probability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of Exceedance</td>
<td></td>
<td></td>
<td>DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td>Required Minimum</td>
<td>2% in 50 years WSRC-TM-95-1 (SRS Engineering Standards Manual: Standard No. 01060: Structural Design Criteria⁷⁰)</td>
<td>2% in 50 years WSRC-TM-95-1⁷⁰</td>
<td>4 x 10⁴</td>
</tr>
<tr>
<td>Annual Hazard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceedance Probability</td>
<td></td>
<td></td>
<td>DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td>Importance Factor</td>
<td>1.0 WSRC-TM-95-1⁷⁰</td>
<td>1.5 WSRC-TM-95-1⁷⁰</td>
<td>Not Applicable (N/A)</td>
</tr>
<tr>
<td><strong>WIND</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Hazard</td>
<td>2x10²</td>
<td>1x10²</td>
<td>1 x 10³</td>
</tr>
<tr>
<td>Exceedance Probability</td>
<td></td>
<td></td>
<td>DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td>Three-Second Wind</td>
<td>100</td>
<td>107</td>
<td>133</td>
</tr>
<tr>
<td>Speed, mph</td>
<td></td>
<td></td>
<td>WSRC-TM-95-1⁷⁰</td>
</tr>
<tr>
<td>Missile Criteria</td>
<td>N/A</td>
<td>N/A</td>
<td>2 x 4 timber (15 pound) moving horizontally at 50 mph, up to a height of 30 ft. DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td>Importance Factor</td>
<td>1.0 WSRC-TM-95-1⁷⁰</td>
<td>1.15 WSRC-TM-95-1⁷⁰</td>
<td>1.0 DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td><strong>TORNADO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Hazard</td>
<td>N/A</td>
<td>N/A</td>
<td>2 x 10⁵</td>
</tr>
<tr>
<td>Exceedance Probability</td>
<td></td>
<td></td>
<td>DOE-STD-1020-2002⁶⁴</td>
</tr>
<tr>
<td>Three-Second Wind</td>
<td>N/A</td>
<td>N/A</td>
<td>180</td>
</tr>
<tr>
<td>Speed, mph</td>
<td></td>
<td></td>
<td>WSRC-TM-95-1⁷⁰</td>
</tr>
<tr>
<td>Atmospheric Pressure</td>
<td>N/A</td>
<td>N/A</td>
<td>70 pounds per square foot (psf) at 31 psf/second WSRC-TM-95-1⁷⁰</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missile Criteria</td>
<td>N/A</td>
<td>N/A</td>
<td>2 x 4 timber (15 lb) moving horizontally at 100 mph, up to a height of 150 ft or vertically at 70 mph up to a height of 150 ft (DOE-STD-1020-2002⁶⁴) 3-inch diameter standard steel pipe (75 lb) moving horizontally at 50 mph, up to a height of 75 ft or vertically at 35 mph up to a height of 75 ft (DOE-STD-1020-2002⁶⁴)</td>
</tr>
</tbody>
</table>
Table 9-1. Natural Phenomena Hazard Criteria (cont.)

<table>
<thead>
<tr>
<th>Performance Category</th>
<th>PC-1</th>
<th>PC-2</th>
<th>PC-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOOD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Hazard</td>
<td>2x10(^{-3})</td>
<td>5x10(^{-4})</td>
<td>1 x 10(^{-4}) DOE-STD-1020-2002(^{64})</td>
</tr>
<tr>
<td>Exceedance Probability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Design</td>
<td>See Sections 9.3.7 and 9.3.8</td>
<td>See Sections 9.3.7 and 9.3.8</td>
<td>See Sections 9.3.7 and 9.3.8</td>
</tr>
<tr>
<td>Design Basis Flood</td>
<td>N/A (See Section 9.3.5)</td>
<td>N/A (See Section 9.3.5)</td>
<td>16.3 inches in 24 hours (WSRC-TM-95-1, SRS Engineering Standards Manual: Standard No. 01110: Civil Site Design Criteria(^{71}))</td>
</tr>
<tr>
<td>(DBFL)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9.3 Design Loads

The SWPF SSCs will be designed for all applicable loads and load combinations including dead loads, live loads, wind loads, tornado wind loads, seismic loads, flood loads, earth and groundwater pressures, snow loads, temperature, and rain loads, along with static and dynamic settlement loads. These loads shall be calculated by using the methods described below.

9.3.1 Dead Loads

Dead loads include the self-weight of the SSC and any superimposed loads. Superimposed dead loads are listed in Table 9-2. Superimposed dead loads for “Mechanical and Electrical” are maximums and may be reduced, depending on the final arrangement of systems and components in the building.

Table 9-2. Superimposed Dead Loads

<table>
<thead>
<tr>
<th>Area and Element</th>
<th>Dead Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Structure:</td>
<td></td>
</tr>
<tr>
<td>Roof:</td>
<td></td>
</tr>
<tr>
<td>Ceiling</td>
<td>5 psf</td>
</tr>
<tr>
<td>Mechanical and Electrical</td>
<td>25 psf</td>
</tr>
<tr>
<td>Roofing</td>
<td>10 psf</td>
</tr>
<tr>
<td>Typical Floor:</td>
<td></td>
</tr>
<tr>
<td>Mechanical and Electrical</td>
<td>25 psf</td>
</tr>
<tr>
<td>Partition</td>
<td>10 psf</td>
</tr>
<tr>
<td>Concrete Structure:</td>
<td></td>
</tr>
<tr>
<td>Roof:</td>
<td></td>
</tr>
<tr>
<td>Roofing</td>
<td>10 psf</td>
</tr>
<tr>
<td>Mechanical and Electrical</td>
<td>25 psf</td>
</tr>
<tr>
<td>Typical Floor:</td>
<td></td>
</tr>
<tr>
<td>Mechanical and Electrical</td>
<td>25 psf</td>
</tr>
<tr>
<td>Partition</td>
<td>10 psf</td>
</tr>
</tbody>
</table>
The equipment loading in the Process Building is mainly influenced by the tankage. The weights of individual tanks are considered in the analysis and design of the CPA, CCA, and AFF portions of the Process Building. Equipment and tank anchorage and supporting slabs shall be designed for the reactions from all loading combinations.

9.3.2 Live Loads

Live loads listed in Table 9-3 shall be used in SWPF design. Additional detailed information on Live Load magnitudes and their application are provided in Section 6.2 of P-ESR-J-00002\textsuperscript{62}.

<table>
<thead>
<tr>
<th>Area and Element</th>
<th>Live Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>20 psf</td>
</tr>
<tr>
<td>Floors</td>
<td>125 psf</td>
</tr>
<tr>
<td>Platforms and Catwalks</td>
<td>60 psf</td>
</tr>
</tbody>
</table>

9.3.3 Wind Loads

The performance goals established for PC-1 and PC-2 are met by model codes or national standards (see discussion in DOE-STD-1020-2002\textsuperscript{64}). These criteria do not account for the possibility of tornado winds or wind-driven ballistics, unless the structure is located in a “Wind-Borne Debris Region”. The SWPF is not in a “Wind-Borne Debris Region”, as defined by American Society of Civil Engineers (ASCE) 7-02, Minimum Design Loads for Buildings and Other Structures\textsuperscript{72}. Criteria for PC-3 design do account for tornado winds and associated wind-driven ballistics. For structures that are intentionally sealed, consideration of tornado winds must also include the effects of atmospheric pressure changes.

PC-1 SSCs are equivalent to Category II, as defined in ASCE 7-02\textsuperscript{72} or IBC-2003\textsuperscript{59}. The structure shall not collapse at design wind speeds. Complete integrity of the structure envelope is not required because no significant quantities of toxic or radioactive materials are present.

PC-2 SSCs are equivalent to Category IV, Essential Facilities, as defined in ASCE 7-02\textsuperscript{72} or IBC-2003\textsuperscript{59}. In addition to ensuring that the structure does not collapse at design wind speeds, the loading is increased by using an Importance Factor greater than one (1) to ensure continuous functionality of the structure during and after the design wind event. Complete integrity of the structure envelope is not required because no significant quantities of toxic or radioactive materials are present. However, breach of the structural envelope is not acceptable if the presence of wind interferes with the function of an SS SSC that may be housed within the building.

PC-3 design requires a level of performance that exceeds the nominal requirements of ASCE 7-02\textsuperscript{72} and IBC-2003\textsuperscript{59}. DOE-STD-1020-2002\textsuperscript{64} defines requirements for PC-3 that include...
wind-driven ballistics and atmospheric pressure changes. Basic wind speeds for straight-line winds and tornados are greater than would be obtained from ASCE 7-02 and IBC-2003. WSRC-TM-95-1 provides basic wind speeds consistent with the annual hazard exceedance probabilities given in DOE-STD-1020-2002. These basic wind speeds, for both straight-line and tornado, are applied using ASCE 7-02 methodologies.

The structural frame and exterior components of all buildings, tanks, towers, and other exposed structures including movable equipment shall be designed to resist pressures from wind from any direction. Wind load design for buildings and other structures shall be determined in accordance with the procedures in ASCE 7-02, using exposure "C". Basic wind speeds are given in Table 9-1 and are reproduced from WSRC-TM-95-1, Standard No. 01060, Section 5.1.2.3 and Table 7.1.1.

In consideration of WSRC-TM-95-1, Standard No. 01060, the SWPF will provide one or more safe rooms as tornado shelters. The total floor square footage of the safe rooms shall not be less than five square ft per person times the normal occupancy of the facility, plus a provision for facility guests. The life-safety design of tornado shelters in the interiors of new PC-1 and PC-2 structures may be accomplished by choosing structural element sizes and details in accordance with FEMA 320, Taking Shelter From the Storm: Building a Safe Room Inside Your House and FEMA 361. The tornado shelter requirements for a facility may be omitted if a tornado shelter that is suitable for the normal occupancy of the facility already exists in the vicinity of the facility. The walking distance to the shelter should allow personnel adequate time to seek safe refuge upon receiving a tornado warning. The PC-3 design of the CPA for tornado loading meets the intent of the FEMA documentation. Therefore, specific areas within the CPA are designated as tornado shelters for the SWPF; tornado shelters will not be provided within other SWPF structures.

9.3.4 Seismic Loads

For PC-1 and PC-2 SSCs, DOE-STD-1020-2002 requires that seismic design be in accordance with IBC-2003 in its entirety. IBC-2003 directs the designer to ASCE 7-02 for most seismic provisions. Seismic load design shall be determined in accordance with IBC-2003 and ASCE 7-02. PC-1 and PC-2 SSCs will be seismically designed or evaluated, using the approaches specified in building code seismic provisions. For PC-1 or PC-2 SSCs, seismic coefficients are obtained from model building codes. Criteria for PC-3 seismic design are developed from the requirements contained in DOE-STD-1020-2002. Dynamic analysis or equivalent static methods can be performed by using either site-specific seismic input or generic input that is considered applicable to the specific site.

PC-1 and PC-2 structures meeting IBC-2003 requirements for plan and section regularity of stiffness and mass may be analyzed, using the equivalent static method. A dynamic analysis must be performed on structures not meeting these requirements. When a dynamic analysis is required, the response spectra method of dynamic analysis shall be used. The response spectra will be determined in accordance with the provisions of IBC-2003. No time history analysis or
soil structure interaction analysis shall be required to be implemented for PC-1 or PC-2 structures.

Seismic response of PC-3 structures shall be evaluated by using either dynamic analysis or equivalent static methods, as permitted by DOE-STD-1020-2002\textsuperscript{64}. These methods include consideration of Soil Structure Interaction effects. DOE-STD-1020-2002 refers to ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures*\textsuperscript{74} for acceptable methods of analysis, which include both Modal and Time History Analysis. Seismic loading shall employ Site-specific Response Spectral Curves or generic curves considered acceptable for the SRS site. Seismic inputs are required in three orthogonal directions (two horizontal and one vertical). Time Histories compatible with the Site-Specific Response Spectral Curves provided in WSRC-TM-95-1, Standard 01060\textsuperscript{70}, will be used to create the pseudo-static loads for performing PC-3 building analysis. The Soil-Structure Interaction will also be used to calculate In-Structure Response Spectra, which will be used by other engineering disciplines in the design of PC-3 systems and components. Time History input accelerations must be compatible with the Response Spectra developed or selected for the SRS site. Soil Structure Interaction effects will be addressed by performing analyses, using the proprietary software SASSI.

### 9.3.5 Flood Loads

All of the floods represented in WSRC-IM-2004-00008\textsuperscript{50} were the result of excess precipitation runoff and the associated creek or stream flooding. This document notes that the flood waters resulting from the Probable Maximum Flood (PMF) rise to 125 ft (MSL) near S-Area. The SWPF occupies J-Area, which is immediately adjacent to S-Area, and has an average existing grade of approximately 277 MSL. On the basis that J-Area is approximately 150 ft above the highest nearby PMF waters, flooding is not considered a credible threat for the SWPF. However, partial site flooding due to locally intense precipitation could occur. Therefore, a site runoff analysis will be performed for the 24-hour storm corresponding to the highest SSC PC at the SWPF. Table 9-1 provides design rainfall data corresponding to the PC-3 event. PC-1 and PC-2 rainfall data are not provided in the table because the runoff analysis will be performed for the entire SWPF Operations Area, which includes all SWPF structures.

### 9.3.6 Earth Pressures

Every foundation wall or other wall serving as a retaining structure shall be designed to resist the incident lateral static earth pressures and surcharges. Calculation of static earth pressure magnitudes are the same for PC-1, PC-2, and PC-3 structures and will employ applicable Rankine coefficients. The design will also consider dynamic earth pressures induced by seismic events. Pseudostatic methods will be employed to calculate increased earth pressures due to seismic loading for portions of PC-1 and PC-2 structures below grade. Dynamic earth pressures on portions of PC-3 structures below grade will follow the Elastic Solution methodology presented in ASCE 4-98\textsuperscript{74}. Soil earth pressure values are provided in the Geotechnical Engineering Report (22-1-02374-500\textsuperscript{48}). These values are presented in P-ESR-J-00002\textsuperscript{62}, which also discusses acceptable methodologies.
9.3.7 Snow Loads

Snow loads, full or unbalanced, shall be substituted for roof live loads, where such loading results in larger members or connections. Snow loads for buildings and other structures shall be in conformance with ASCE 7-02\textsuperscript{72}. For SRS, the ground snow loading specified is 10 psf. The ground snow loading will be adjusted, using ASCE 7-02 exposure, thermal, and importance factors applicable to PC-1, PC-2, and PC-3 design.

9.3.8 Rain Loads

Rain loads shall be obtained in accordance with IBC-2003\textsuperscript{59} and ASCE 7-02\textsuperscript{72}. The SWPF roof drainage systems shall be designed to accommodate a 25-year, 6-hour rainfall event (4.5-inch total accumulation, per SRS). Rain loads for structural design shall be determined in accordance with ASCE 7-02, Section 8.0. Loading is a function of the depth of water that could be penned on the roof if the primary roof drainage system is blocked. Rain loads are not applicable to the SWPF buildings for the following two reasons:

1. Roof drainage is via gutters and leaders. There are no roof features (e.g., parapets) that could pen water on the roof. Should the leaders become blocked, the rain water would overflow the gutters; and

2. Roof slopes are a minimum ¼ to 12 slope. Consideration of ponding is, therefore, not required by the governing Codes and Standards.

9.3.9 Ice Loads

Ice-sensitive structures, and parts thereof, shall be designed to withstand the appropriate ice loads, determined in accordance with ASCE 7-02\textsuperscript{72}. The SWPF buildings are not considered ice-sensitive. Ice loads will be considered for steel superstructures supporting utilities outside the building if they are classified as ice-sensitive.

9.3.10 Impact and Dynamic Loads

Supports for operating machinery shall be designed for the loads provided by the equipment manufacturer. These loads are typically given as reactions at the support points.

9.3.11 Crane Loads

Crane impact, lateral, and longitudinal loading shall be in accordance with IBC-2003\textsuperscript{59}. Crane rail support girder deflection limits shall be as prescribed by the crane manufacturer. Crane wheel loads under full lift shall be based on manufacturers’ actual loads or the Whiting Crane Handbook\textsuperscript{75}, if a specific vendor has not been determined at the time of design. The effects of mobile construction crane loads on buried structures shall be considered.
9.3.12 Hydrostatic and Fluid Loads

9.3.12.1 Hydrostatic Loads

All structures in the SWPF Process Building have shallow foundations. Based on data provided in 22-1-02374-500, the mean groundwater table is about 39 ft below existing grade at approximately elevation 245 MSL. The lowest portion of the SWPF Process Building basements will be at about Elevation 260 MSL, or approximately 15 ft above the groundwater table. Therefore, the structures will not be subjected to external hydrostatic loads.

9.3.12.2 Fluid Loads

A Fluid Load will be applied to Process Cell walls to account for pressures imposed on the walls due to tank failure and loss of its entire liquid inventory. Loads will be generated and applied to only one cell, the cell with the tank containing the largest liquid inventory. Fluid loads acting vertically (i.e., buoyancy) will be applied to tanks in the CPA Process Cells where the total volume of fluid that can accumulate in the cell rises above the bottom of the tank. This buoyancy load will be applied as part of the anchorage design for tanks subjected to immersion in the Process Cells.

9.3.13 Self-Limiting Loads

9.3.13.1 Thermal Effects

Climatic thermal effects do not have to be applied as thermal in loads in the design of the PC-3 CPA concrete structure or the PC-1 steel buildings. Thermal gradients and uniform temperature changes in the CPA structure are below the values specified in Section 1.3 of American Concrete Institute (ACI) 349.1R-07, Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures for consideration of thermal effects in the design of concrete structures. The need to account for thermal effects in the steel buildings is evaluated based on Federal Construction Council (FCC) Technical Report No. 65, Expansion Joints in Buildings. Based on the criteria in this report, the steel building lengths do not exceed the allowable lengths permitted for steel structures without expansion joints.

9.3.13.2 Settlement

Differential settlement loads shall be evaluated, based on the anticipated settlements predicted by several Geotechnical Investigation Reports.

Static Settlements for the SWPF PC-1 steel buildings shall be obtained from 22-1-02374-500. Dynamic settlements for the PC-3 concrete building shall consider three settlement troughs documented in Calculation CJC-SRS-C-001, SWPF GTStrudl Input for Post-Seismic Differential Settlement, along with Differential Soil Profiles provided in K-ESR-J-00002.
9.3.14 Load Combinations

Load combinations used for design of an SSC are based on the SSC PC and its structural material. Where loads may reverse (such as wind and seismic), both directions of loading shall be considered.

When the SSC design is based on ultimate strength design (concrete) or allowable strength design (steel), each element shall be designed to resist the most critical effects of the load factors and load combinations. Load combinations shall be determined in accordance with WSRC-TM-95-1, Standard No. 01060, Section 5.3\textsuperscript{70}, IBC-2003\textsuperscript{59}, ASCE 7-02\textsuperscript{72}, American Concrete Institute (ACI) 318-02, Building Code Requirements for Structural Concrete and Commentary\textsuperscript{79}; and/or ACI 349-01/349R-01, Code Requirements for Nuclear Safety Related Concrete Structures & Commentary\textsuperscript{80}, as applicable. The design load applications are provided in Section 7.0 of P-ESR-J-00002\textsuperscript{62}.

9.4 Reinforced Concrete Properties

All structural concrete shall have a minimum field unit weight of 140 pounds per cubic ft. For design purposes, a unit weight of 150 pounds per cubic ft is used. Table 9-4 and Table 9-5 provide the design properties for concrete and reinforcing steel that will be used in SWPF structural calculations.

**Table 9-4. Minimum Compressive Strength of Concrete at 28 Days**

<table>
<thead>
<tr>
<th>Element</th>
<th>Compressive Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous Concrete (mud mats)</td>
<td>2,000 pounds per square inch (psi)</td>
</tr>
<tr>
<td>Footings</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Mats</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Basement Walls and Retaining Walls</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Walls and Columns</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Floor Slabs</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Roof Slab</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Floor Slabs on Metal Deck</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Precast concrete panels and beams</td>
<td>5,000 psi</td>
</tr>
<tr>
<td>Sidewalks, curbs, thrust blocks, fence and guard post embedment, underground duct bank encasement</td>
<td>3,000 psi</td>
</tr>
</tbody>
</table>
### Table 9-5. Reinforcing Deformed Bars

<table>
<thead>
<tr>
<th>Element</th>
<th>Yield Strength/Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebar</td>
<td>American Society for Testing and Materials (ASTM) A706 Grade 60 Low Alloy Deformed Bars</td>
</tr>
<tr>
<td>Welded Wire Fabric</td>
<td>ASTM A185 Welded Wire Reinforcement</td>
</tr>
</tbody>
</table>

### 9.5 Structural Steel, Miscellaneous Steel, and Metal Deck

All structural steel will be hot-rolled standard mill shapes or welded built-up plate members. All fire-rated structural steel will be protected with fire-proofing sufficient to achieve the assigned fire rating. Table 9-6 provides design properties for structural steel and metal decks to be used for the SWPF.

### Table 9-6. Structural Steel and Metal Decks

<table>
<thead>
<tr>
<th>Element</th>
<th>Yield Strength/Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>All W Sections</td>
<td>ASTM A992, Grade 50</td>
</tr>
<tr>
<td>Rolled Angles, Gusset Plates, Column Bases, Channels</td>
<td>ASTM A572 Grade 50 (Fy=50 ksi)</td>
</tr>
<tr>
<td>Pipe</td>
<td>ASTM A500, Grade B, (Fy = 42 Kips per square inch [ksi])</td>
</tr>
<tr>
<td>Structural Tubes</td>
<td>ASTM A500, Grade B (Fy = 46 ksi)</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>ASTM A240, Type 304</td>
</tr>
<tr>
<td>Miscellaneous Steel (angles, channels, etc.)</td>
<td>ASTM A36</td>
</tr>
<tr>
<td>High Strength Bolts</td>
<td>ASTM A325</td>
</tr>
<tr>
<td>Welds</td>
<td>American Welding Society D1.1, D1.3, and D1.6</td>
</tr>
<tr>
<td>Metal Decks</td>
<td>1 ½” to 3” deep, ASTM A653 Grade 33, 18 gauge minimum. Galvanized, where applicable, using zinc coat finish conforming to ASTM A924.</td>
</tr>
<tr>
<td>Shear Studs</td>
<td>ASTM A108 3/4” diameter x 4 1/2” unless noted otherwise.</td>
</tr>
<tr>
<td>Cast-in-Place Anchor Bolts</td>
<td>ASTM F1554, Grade 36 ksi</td>
</tr>
</tbody>
</table>

### 9.6 Masonry

The compressive strength of materials selected for masonry, grout, and mortar to be used in structural calculations is provided in Table 9-7.
### Table 9-7. Masonry, Grout, and Mortar

<table>
<thead>
<tr>
<th>Element</th>
<th>Compressive Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Masonry Units</td>
<td>ASTM C-90 Grade N, Type I Light Weight, fm = 1,500 psi</td>
</tr>
<tr>
<td>Grout</td>
<td>ASTM C476 fc' = 2,500 psi</td>
</tr>
<tr>
<td>Mortar</td>
<td>ASTM C270 fc' = 2,500 psi Type ‘N’ interior ‘S’ Exterior</td>
</tr>
</tbody>
</table>

## 10.0 CIVIL DESIGN

This section provides the civil engineering design basis for the SWPF Project. The civil engineering site work scope includes: site preparation; clearing, excavation, and compaction of fill soil; and grading, roads, walkways, and parking. New utilities including stormwater drainage, sanitary sewers, DW, fire water, underground power, communications, and WTLs are also addressed. The civil engineering design is grouped under the following categories:

- Site Preparation and Earthwork,
- Stormwater Management,
- Underground Utilities and WTLs, and
- Roads.

For excavations, backfill, and earthwork activities, the basis for design has considered the recommendations given in the Geotechnical Engineering Report (22-1-02374-500)\(^\text{48}\); these recommendations have been incorporated without change where possible, while others have been modified based on engineering judgment and experience at SRS.

### 10.1 Site Preparation and Earthwork

Existing unpaved roads to the north and south of the SWPF site boundary will be improved to provide access to J-Area without using the DWPF access gate. These roads will be widened, regraded, and surfaced (as necessary) to handle heavy construction and personnel traffic. New gravel roads will be constructed (as necessary) to facilitate the safe flow of traffic during the Construction phase of the Project. Areas designated for temporary facilities (including parking areas, field offices, change shacks, tool room, and materials and equipment storage areas) will have crushed rock installed. Existing buildings within J-Area will be demolished and disposed prior to construction. Portions of the employee parking lot and an area west of the proposed SWPF site will be designated for use as laydown, fabrication, and staging areas. Preparation of the western laydown area will include removal of approximately 1,000 ft of an existing rail spur.
10.1.1 Sitework and Grading

The site shall be prepared in building areas prior to construction. Clearing and grubbing of brush, stumps and roots shall be performed. Organic soils shall be stripped and stockpiled. Existing utilities shall be demolished, capped, terminated, or otherwise abandoned, as required.

The temporary facilities will have built-up crushed rock pads installed to maintain serviceability during rainy periods. Preliminary rough grading will establish flow lines to ensure that the site stormwater will be directed away from aboveground construction areas. Flow channels will convey this runoff to the permanent SWPF detention basin, which will act as a sediment basin during construction. Installation of this basin will be among the first grading activities at the site.

Low points will be established in utility trenches and excavation pits to collect rainwater. This rainwater will be pumped to the nearest flow channel to maintain dry conditions in trenches and excavations. An adequate inventory of stormwater removal pumps will be available during construction to protect the site. General drainage onsite will be controlled using Best Management Practices (BMP) that include silt fencing, sediment traps, and check dams. These devices will control erosion and reduce the soil sediment suspended in the runoff that flows to the sediment basin. The sediment basin will further reduce suspended solids and attenuate stormwater flow before it is discharged offsite. The BMP features and basin discharge points will be inspected and monitored during construction, as required by South Carolina Regulation (SCR) 72-300 – 72-316, Standards for Stormwater Management and Sediment Reduction and SCR100000, NPDES General Permit for Stormwater Discharges from Construction Activities.

Areas shall generally be graded at 2% slope away from buildings for the first 10 ft, and as required to the site boundary. Building pads shall be graded level, unless the building design calls for a split-level or sloping pad. The permanent storm drainage system is described in Section 10.2.

10.1.2 Excavation, Backfill, and Compaction

The building design will generally avoid deep excavations. This design reduces the cost for shoring and reduces the expense associated with dewatering. The deepest excavations will occur below the ASDT Cell and the WTL Enclosure in the Process Building, the sanitary lift station located to the north, and storm drainage lines to the east and west of the Process Building. These excavations will be approximately 12 to 20 ft deep. Excavation for the Process Building will average approximately 4 to 5 ft. Side slopes for excavations will be laid back at slopes recommended in the Geotechnical Engineering Report (22-1-02374-50048), which recommends that 1.5H/1V temporary slopes, based on the requirements of 29 CFR 1926, Subpart P: Excavations up to 20 ft deep under certain conditions. Steeper side slopes are acceptable, based upon evaluation by an excavation Competent Person, as defined in 29 CFR 1926 and approved by the EPC. At least two access ramps shall be provided in all large excavations for movement of equipment and personnel. All excavations will conform to the requirements of 29 CFR 1926 and DOE O 440.1A, U.S. Worker Protection Management for Federal and Contractor Employees.
Compaction for common and engineered fill shall be in accordance with Project specifications. Areas that will not be developed in the future or that have no present or proposed development will receive minimum compactive effort.

10.1.3 Trenching

Excavation for utility lines shall be in accordance with Project specifications, applicable safety regulations, and impact(s) that trenching might have on utility lines. Trenching shall conform to the requirements of 29 CFR 1926, Subpart P<sup>83</sup>, and DOE O 440.1A<sup>84</sup>. Geotechnical recommendations regarding trench excavation and backfill have been incorporated into the specifications, design drawings, and construction management. Trenching in close proximity to existing utility trenches shall be avoided.

10.1.4 Trench Backfill

Backfill methods and materials were evaluated and chosen based on bedding requirements, effects on alignment and grade, and risk of damage to conduits. Trench compaction was specified with regard for relative costs, effectiveness, expediency, and efficiency. Trench backfill requirements have considered the relevant requirements of WSRC-IM-95-58, SRS Engineering Practices Manual, Engineering Guide No. 02224-G: Excavation, Backfill, Placement of Low Permeability Soil and Grading<sup>85</sup>.

10.2 Stormwater Management

The SWPF drainage system shall be designed per the requirements of SCR 72-300 – 72-316<sup>81</sup>; SCR1000000<sup>82</sup> (which is applicable during the Construction phase); and SCR000000, NPDES General Permit for Storm Water Discharges Associated with Industrial Activity (Except Construction)<sup>86</sup>. The SWPF shall be designed to collect and route runoff from roofs and paved and undeveloped areas within J-Area.

Consistent with the provisions of SCR 72-300 – 72-316<sup>81</sup>, the SWPF drainage system during Construction shall be designed for the 10-year, 24-hour storm event. BMPs used during construction will provide a removal efficiency of 80% for suspended solids or 0.5 milliliters per liter peak settleable concentration, whichever is less. During Operations, the drainage system shall be designed to control runoff from the 2-, 10-, and 25-year 24-hour storm events. South Carolina rainfall data for the 2-, 10-, and 25-year 24-hour storm events are provided in Table 10-1.
Table 10-1. Rainfall Accumulation in Inches for 2-, 10- and, 25-Year Return Periods

<table>
<thead>
<tr>
<th>Annual Hazard Exceedance Probability</th>
<th>Return Period (Years)</th>
<th>24 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>5x10^{-1}</td>
<td>2</td>
<td>3.7</td>
</tr>
<tr>
<td>1x10^{-1}</td>
<td>10</td>
<td>5.8</td>
</tr>
<tr>
<td>4x10^{-2}</td>
<td>25</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Source: *South Carolina Stormwater Management and Sediment Control Handbook for Land Disturbance Activities*. 87

A stormwater detention basin will be constructed south of J-Area to collect water runoff from J-Area during operations. Stormwater diversions or berms will be constructed north and northwest of J-Area, if necessary, to prevent water run-on. Design details for the detention basin and routing of stormwater drainage shall be specified in the SWPF Stormwater Management and Sedimentation Control Plan. The detention basin capacity and outlet structure shall be designed to ensure that post-development flow does not exceed pre-development flow for the design storm events. The detention basin shall be equipped with an emergency spillway to prevent erosion and washout of Road 50-25.2 should the basin overtop during an extreme storm event. During construction, the detention basin shall be undercut to provide capacity for sediment deposition that may occur due to erosion. The capacity of the detention pond shall include volume to detain the first flush for a 24-hour period, in accordance with SCR 72-300 – 72-316. 81

A PC-3 DBFL hydrology calculation has been performed. The results indicate that localized flooding will not negatively impact SSCs (see also Section 9.3.5).

10.2.1 Storm Drain Conveyances

Stormwater runoff from buildings, roadways, and other surfaces on the SWPF site will be collected and routed to the detention basin through a system of surface swales, underground pipes, culverts, storm drain manholes, and catch basins. Surface swales shall be either grass- or rip-rap-lined. The minimum line size for storm drains shall be 12 inches. The minimum diameter for storm drain laterals is 8 inches. Storm system piping 12 inches in diameter and greater shall be ASTM C76-03, *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*. 88 ASTM A716-03, *Standard Specification for Ductile Iron Culvert Pipe* 89 may be used for culverts with low depths of cover. Building storm drain laterals shall conform to ASTM A716-03 or ASTM D3034-08, *Standard Specification for Type PSM (Vinyl Chloride) (PVC) Sewer Pipe and Fittings*. 90 Storm drain manholes shall be in accordance with ASTM C478-06a, *Standard Specifications for Precast Reinforced Concrete Manhole Sections* 91 and have shaped bottoms and ledges on either side of the main line.

Ledges shall slope at 5% to the channel and shall intersect the projected pipeline channel at mid-height. Frames and covers shall be heavy-duty ductile or cast iron with a minimum 24-inch inside diameter. Ladders or ladder rungs shall be provided in accordance with ASTM C478-06a. 91
Inlets to storm drains may be either curb inlets or gratings. Gutter spread shall be limited to ½ of the travel way or 8 to 10 ft from the face of curb. Gutter spread shall be based on a 10-year, 24-hour storm. Grated inlets shall be designed to operate under weir flow conditions. Orifice flow shall be avoided. Grated inlets shall be designed for a 10-year, 24-hour storm.

10.2.2 Unoccupied Site Areas

Portions of the site that are not occupied by buildings, structures, or pavement shall have adequate continuous slopes to drain toward water courses, drainage swales, and storm drain inlets. The runoff shall be carried under walkways and roads in pipes that are large enough to preclude clogging by debris or grass cuttings. Turf banks, where needed, shall be graded to permit the use of gangmowers and shall provide a maximum slope of 3:1. The tops and bottoms of slopes shall be gently rounded in a transition curve for optimum appearance and ease of maintenance.

10.2.3 Culverts

Culverts shall be provided where the natural drainage pattern is interrupted. This may be necessary for new roads, where existing roads are improved, or when obstructions such as existing fence lines exist. Existing culverts may be rerouted, if required.

The following guidelines shall apply to culvert design:

1. Minimum diameter shall be 12 inches;
2. Minimum gradient shall be 0.5%, where possible; however, flow shall be subcritical;
3. Culvert alignment shall be in the direction of storm flow and shall be as perpendicular to roads or obstructions when possible; and
4. An end wall with downstream channel protection (e.g., paved apron, riprap, channeling, or an energy dissipator) shall be provided below the culvert outlet, where necessary. Generally, a headwall shall also be used at the upstream end. Debris barriers with access for cleaning shall be provided, where necessary.

10.2.4 Erosion Control

Erosion control measures shall be implemented during SWPF construction and operation. Such measures shall include the following:

1. Interim and permanent stabilization practices such as temporary and permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, and preservation of mature vegetation, with site-specific scheduling of implementation of these practices;
2. Structural practices (silt fences, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe protection, reinforced soil retaining systems, gabions, and temporary
or permanent sediment basins) to divert flows from exposed soils, store flows, or otherwise limit runoff from exposed areas; and

3. Stormwater management measures that will be installed during construction to control pollutants in stormwater discharges that occur after construction has been completed. Such measures may include stormwater detention structures, stormwater retention structures, flow attenuation through use of open vegetated swales and natural depressions, infiltration of runoff onsite, and sequential systems combining several practices.

S-EIP-J-00001\(^{10}\) describes the permitting process details associated with stormwater discharge and erosion control measures. Stormwater runoff at SRS is governed by two separate permits. SCR000000\(^{86}\) is applicable during the Operations phase of the facility. SCR100000\(^{82}\) is applicable during the Construction phase of the facility.

To obtain coverage under the State of South Carolina NPDES General Permits, the EPC will prepare separate SWPPPs to address water runoff and sediment control measures during construction and operations.

### 10.3 Underground Utilities and WTLs

All utility supplies to the SWPF are underground. All WTLs to and from the SWPF are installed below grade for shielding purposes. Shielding calculations are in accordance with PP-RP-4501, As Low As Reasonably Achievable (ALARA) Review\(^5\). The hot tie-ins to existing WTLs will be performed by the LWO and M&O. The LWO and M&O or the EPC will install the piping and cable/conduit from the SWPF up to the interface points, as specified in each relevant ICD.

Installation of the utility supply piping, electrical, and signal duct banks shall be coordinated to avoid damage and minimize impacts to other construction activities. The majority of trenching, pipe, or duct bank installation and backfill will be performed before major construction work begins. Physical barriers will be installed or areas will be roped off to identify no-traffic zones for heavy construction equipment.

#### 10.3.1 Pipe Crossings

Pipe crossings at existing roads shall be installed so that the angle between the roadway axis and the axis of the crossing is as near 90 degrees as practicable. These pipes will be installed in a trench. After the pipes are installed, the trench will be backfilled with approved material and compacted. The base course and surface coat shall be installed according to the original road specifications. Appropriate end treatment shall be effected for conditions encountered.

Radioactive waste feed will be transferred to the SWPF (WTE) from the Tank Farm via underground waste feed lines. MST/sludge and strip effluent will be transferred from the SWPF to DWPF via underground WTLs to the DWPF. These lines will run under SRS Track C and will be installed by open cut and cover means. SRS Track C shall be restored following installation of WTLs. Other utilities and electrical and signal duct banks will also be installed.
below grade and, in some cases, will be below existing DWPF roads. The same requirements specified in the preceding paragraph also apply to these WTLs and utilities.

10.3.2 Domestic Water Supply

The SWPF DW System supplies potable water for personnel and utility uses. These uses include restrooms, personnel showers, janitorial closets, drinking fountains, safety showers, eyewash stations, and hose bibbs. DW will also supply make-up to the PW and DI Systems. The DW System will not supply, interconnect, or be shared with the fire protection water supply. The potable water supply shall be sized according to the 2003 International Plumbing Codes Handbook\(^92\).

The SWPF DW System will be supplied by a connection to the existing S-Area DW System. A tie-in connection will be located on the existing 4-inch DW header located on the northeast corner of Building 717-11S. V-ESR-J-00002\(^14\) describes this tie-in. The Site DW System will supply the DW at approximately 60-80 pounds per square inch gauge (psig) within the SWPF. The peak demand to SWPF is estimated at 184 gallons per minute (gpm) (105 gpm for potable, 4 gpm for cooling makeup and 75 gpm for process). All DW piping will comply with the codes and requirements of the 2003 International Plumbing Codes Handbook\(^92\) and ANSI/American Water Works Association (AWWA) requirements.

An air gap at the top of the PW Storage Tank will be provided to prevent contamination of the DW System. The supply lines or fittings for every plumbing fixture shall be installed to prevent backflow, per the 2003 International Plumbing Codes Handbook\(^92\).

10.3.3 Fire Water Supply

The underground Fire Water supply for the SWPF shall be designed in accordance with NFPA 24, Standard for the Installation of Private Fire Service Mains and their Appurtenances\(^93\). This supply will be part of a new supply loop that also provides fire hydrant coverage for the exterior of the facility.

Two underground lead-ins branching off the new supply loop will supply the interior systems of Process Building. Two other independent lead-ins will supply the suppression systems for the Administration and Compressor Buildings. Post-indicator valves will provide isolation and segmentation of the new system, and gate valves with extension boxes will provide shut-off capabilities for the yard hydrants. V-ESR-J-00017\(^26\) describes the interface between the Site Fire Protection Water Supply System and the SWPF Fire Protection Water System.

10.3.4 Sanitary Sewers

The Sanitary Sewer lines shall be designed to discharge sanitary sewage based on the maximum number of personnel in a work shift, as specified in P-ESR-J-00011\(^12\). Line sizes shall be based on the Fixture Unit Method of calculation, in accordance with the 2003 International Plumbing Codes Handbook\(^92\). The Manning Formula will be used to determine the slope, pipe size,
velocity, and flow. All pipe sizes shall be sufficient to carry peak flow at a maximum depth of one-half the pipe diameter.

Generally, sewer lines shall be located (if possible) parallel to roads, off the pavement, and in straight runs between manholes. Manholes for gravity lines shall be installed at: the end of each line; at all changes in grade, size, or alignment; at all intersections of piping; and at distances not greater than 400 ft. Clean-outs may be used only for special conditions and shall not be substituted for manholes, except when installed at the end of laterals not greater than 80 ft in length.

The SWPF Sanitary System shall consist of gravity drains from the Process, Compressor, and Administration Buildings, which shall convey sanitary sewage to a lift station located north of the Process Building. A separate gravity system shall convey condensate to a flow-measuring manhole located adjacent to the lift station. The condensate flows from the flow-measuring manhole shall drain by gravity to the lift station. The lift station shall pump the combined sanitary and condensate flows to a manhole located at the northwest corner of the employee parking lot.

The SWPF Sanitary Sewer system will connect to the DWPF Sanitary Sewer System via a new 8-inch gravity sanitary sewer line routed to the north of the Process Building to an existing manhole, MH-96, at SRS Coordinates N73205, and E65280. MH-96 is shown on drawing W761201, Savannah River Plant-2005 Area Defense Waste Processing Facility-Sludge Plant Sanitary Sewer System Plan94. The underground sanitary sewer mains for the SWPF are shown on Drawing C-CY-J-0010, Overall Sanitary Sewer Piping Plan95. There will be no interconnections among the stormwater systems, the sanitary waste system, and radioactive or other hazardous material handling system. V-ESR-J-0000618 describes the interface between the Site Sanitary Sewer System and the SWPF Sanitary Waste System. All design criteria for Sanitary Sewers will conform to the Recommended Standards for Wastewater Facilities96 (also known as “Ten States Standards”) and SCDHEC Regulation SCR 61-67.300, Standards for Wastewater Facility Construction97.

The design of the Sanitary Sewer system shall prevent the possibility of DW System contamination by the Sanitary Sewer system. Sanitary sewers shall be designed to cross under DW lines. All sewers shall be constructed with a minimum 3-ft cover, unless an alternative is approved by SCDHEC. Sewer lines, manholes, pump stations, force mains, and wastewater treatment facilities will be located more than 100 ft from a public water supply well and at least 20 ft from a potable well. Proposed sewers adjacent to existing or proposed potable water supply facilities will comply with SCDHEC Regulation 61-67.30097 requirements governing cross-connections, horizontal and vertical separation distances, crossings, and force mains.

10.3.5 Underground Electrical Lines

The site 13.8-kilovolt (kV) power supply lines will be routed by duct banks from aerial pole line taps on the eastern edge of J-Area. The supply lines will be routed through new manholes to transformer pads located immediately north of the Process Building, south of the Process
Building, and east of the Administration Building. The underground electrical lines will be installed in concrete duct banks at a sufficient depth to protect them from construction traffic. V-ESR-J-00008 describes the interface between the Site M&O and SRS Infrastructure and Support Department for electrical power supply to the SWPF. The underground electrical power distribution for the SWPF is shown on Drawing C-CF-J-0001, *Overall Underground Electrical, Lighting and Communications Plan*.  

10.3.6 Grounding Grids  

Electrical power and instrumentation grounding and lightning protection grounding loops will be provided for the SWPF. The electrical power and instrument grounding systems shall be coordinated and connected in accordance with NFPA 70, *2005 National Electrical Code* and the Grounding and Lightning Protection Systems discussed in Section 16.2.5.  

10.3.7 Underground Process Lines  

The underground WTL plan and profiles for the SWPF are shown on Drawings C-CY-J-0030, *Western Waste Transfer Line Plan and Profile* and C-CY-J-0031, *DSS Waste Transfer Line Plan and Profile*. The underground WTL routes will be marked or barricaded to protect the lines from construction traffic, as required.  

10.3.8 Fiber Optic Cable and Copper Communications  

The fiber optic cable and copper backbone to the SWPF will be routed in underground duct banks or direct buried cable/conduit from SRS Coordinates N72953, E65328 at the northern perimeter of J-Area to both the Process Building (north side) and the Administration Building, as shown on Drawing C-CF-J-0001. The fiber optic and copper rerouting and new installation can be performed independent of the concrete and heavy lifting work. During construction, manholes and underground cable routing will be clearly marked and protected with barriers, as appropriate.  

10.4 Roads  

The SWPF site can be accessed via SRS Roads E or F. Permanent access to the SWPF will be provided by a new 24-ft-wide road independent of S-Area access, as indicated in V-ESR-J-00009. Existing gravel roads shall be used to access the SWPF site during construction. Construction personnel shall gain access during early construction from the north on a gravel road (site secondary road 50-25.2) that turns off the DWPF main entrance road near SRS Road F. Construction personnel shall utilize the north access road for access to SWPF after the road has been paved. Heavy construction traffic will access the site from the south on a gravel road that turns off Road E in H-Area.  

Existing gravel roads to be used during construction shall be improved (as necessary) to safely handle the sizes, weights, and volumes of traffic anticipated. These improvements will include
widening, regrading, and resurfacing, where necessary. A new gravel road segment, approximately 540 ft long, will be part of the improvements to the southern construction access road. This improvement is required to avoid using sections of the existing gravel roadbed that are narrow and contain turn radii that are restrictively small. New gravel roads required within the SWPF site work area during construction shall be established along the roadbeds planned for the permanent asphalt roadways.

Permanent paved roadways shall comply with American Association of State Highway and Transportation Officials (AASHTO) GDHS-4, *Policy on Geometric Design of Highways and Streets*\(^\text{102}\). This will include the geometric design of all roads, access driveways, aprons, and parking areas. Maximum slope of roadways and access drives shall be 6\%. Maximum slope of parking areas shall be 4\%. All grade breaks greater than 1\% shall be provided with vertical curves in accordance with AASHTO GDHS-4. Transverse grades for roadways shall be between 2\% and 4\% to allow cross-drainage. Slope shall preferably be from the road centerline. Pavement width shall be 24 ft. For roads that are around or within the immediate vicinity of clustered building structures, concrete curbs and gutters shall be considered to facilitate drainage, aesthetics, and space clearance requirements. Gutters for guttered curbs shall be 2 ft wide.

### 10.5 Pavement Design

Traffic volumes shall be determined in accordance with Publication IR-016E, *2003 Trip Generation*\(^\text{103}\). Pavement design shall be in accordance with AASHTO *Guide for Design of Pavement Structures*\(^\text{104}\). Minimum design and detail requirements for the construction of pavement shall comply with the *SCDOT Standard Specifications for Highway Construction (2000)*\(^\text{105}\). Joint patterns and details shall be provided for all rigid pavements. The gradation, thickness, and compaction of the gravel base material shall be in accordance with the recommendations in 22-1-02374-500\(^\text{48}\).

### 10.6 Roadway Drainage

Transverse grades shall be between 2\% and 4\% to allow cross-drainage. The slope shall preferably be from the road centerline. A transverse slope may be across the entire road, where required due to intersecting roads, ramps, and driveways. Roadside drainage ditches shall be consistent with the overall site drainage plan and shall be designed to direct stormwater runoff away from buildings, service areas, important support substructures, roadways, and walkways. Stormwater runoff shall be collected and conveyed above grade wherever possible by gutters and ditches. Sump areas, which cannot be drained by gravity, will be provided in the SWPF loading docks. Accumulated liquids will be pumped out manually, as required.

### 10.7 Yard Loading

Yard underground utilities and structures shall be designed for an AASHTO H20-44, *Standard Specification for Highway Bridges*\(^\text{106}\) vehicle loading, where appropriate, to accommodate maintenance vehicles and equipment.
11.0 MECHANICAL DESIGN

This Section addresses the design requirements for SWPF process equipment and mechanical utility support systems. Process equipment includes vessels, CFFs, centrifugal contactors, pumps, mechanical agitators, heat exchangers, electric heaters, filters, eductors, ejectors, in-line mixers, air compressors (including dryers and coolers), chilled water systems, and DI water package unit. A description of the process functions and the basis for process equipment sizing are addressed in P-DB-J-00003. Design requirements for process piping and valves are described in Section 13.0.

The mechanical utility systems addressed in this section include PCHW, Plant Air, breathing air, plumbing system, and insulation. Other utility support systems include HVAC equipment (e.g., CHWSs, heat recovery system, PVVS, and PMVS) presented in Section 14.0 and fire protection systems discussed in Section 15.0.

11.1 Design Life

Section C.7, Paragraph 3.1.2 of the SWPF Contract requires that remotable process vessels have a minimum design life of 10 years. Section C.7, Paragraph 3.13.2 of the SWPF Contract requires that in-cell tanks less than or equal to 30,000 gallons and equipment be designed to allow remote removal and replacement, except where tanks or equipment are designed to operate continuously without the need for major repair or replacement over the design life of the plant. Based on the SWPF Contract requirements, all permanent tanks, vessels, and equipment located within the ASP Process Cells and the CSSX Tank Cells are designed for a service life of 40 years and will not be remotable. Equipment components that require replacement (e.g., CFF tubesheet assembly) are designed for remote replacement without entry into the Process Cell.

11.2 Codes, Standards, and Regulations for Mechanical Design

The codes and standards used to design the SWPF process equipment and mechanical support systems are identified in P-DB-J-00002. The codes and standards for specific process equipment and mechanical systems are identified in the following subsections. Data sheets and specifications will address the application and implementation of specific requirements from these codes and standards. The specifications will address material selection, welding, stress analysis, and nondestructive testing.

11.3 Process Equipment

Process equipment is designed to confine radiological materials and other hazards. The NPH PC assigned to each SSC is commensurate with the DSA to ensure worker protection. The process systems include ASP, CSSX, AFP, and cold chemicals.
11.3.1 ASME Process Vessels

The process vessels located in the ASP Process Cells, CSSX Tank Cells, and AFF provide the primary confinement boundary for radioactive waste. These vessels will be designed and fabricated to meet applicable requirements of the American Society of Mechanical Engineers (ASME) Section VIII, Division 1, *Boiler and Pressure Vessel Code*\(^{107}\). Except for the Solvent Strip Feed Tank, all pressure boundary wetted parts for ASME process vessels will be constructed from 316L stainless steel. The Solvent Strip Feed Tank will be constructed from 304L stainless steel. Non-removable vessels (including internals) installed within the Process Cells will be designed with corrosion and erosion allowances to endure throughout the operating life of the plant. Design analysis and quality requirements will be graded based on the vessel's credited safety-related function classification and PC. The design analysis criteria are presented in G-ESR-J-00003, *SWPF Mechanical Equipment Acceptance Criteria*\(^{108}\). All ASME process vessels will be examined, inspected, and tested to meet code stamping.

The ASME process vessel design is based on an internal pressure of 15 psig and an external pressure of 3 psig. The ASP and CSSX process vessels are actively vented to the PVVS and AFP vessels are vented to the building exhaust system. The external pressure design criterion of 3 psig is specified to withstand the maximum negative static pressure generated by the PMVS discharge fan.

External forces exerted on the vessel as a result of a design basis spill will also be considered as an additional load to the external pressure. The design basis spill for AST-A, FFT-A, Strip Effluent Hold Tank (SEHT), and SSFT Cells is based on leaking the individual tank contents into the cell. In this situation, differential tank pressure would not occur. For the ASDT Cell, the design basis spill is the contents of the SSFT draining into the SDT via the process drain lines. In this situation, the ASDT Cell would fill and start to flow into the Spent Acid Storage Tank and ASDT through their respective overflows, thus equalizing any differential pressure (dP) before exceeding the external design pressure for the tanks. For the SSRT/WWHT Cell, the design basis spill is the contents of the WWHT leaking into the cell, resulting in a liquid height of approximately 2 ft, which is less than the external design pressure.

The ASME process vessels will be qualified for structural integrity anchorage and leak tightness for seismic loadings appropriate to their assigned PCs (i.e., PC-1 or PC-3). For PC-3 vessels, seismic qualification is for anchorage and for leak tightness and will be performed by the methods outlined in ASCE 4-98\(^{74}\), as prescribed by DOE-STD-1020-2002\(^{64}\). All PC-3 vessels will be seismically qualified by modal analysis using in-structure response spectra per ASCE 4-98\(^{74}\), Section 3.5.4. Forces due to sloshing of fluid will be taken into consideration for PC-3 vessel seismic qualification. Consistent with DOE-STD-1020-2002, PC-1 vessels and equipment will be seismically qualified for anchorage only, using equivalent static methods per IBC-2003\(^{59}\) and ASCE 7-02\(^{22}\), Section 9.6.
11.3.2 Compressed Air and Miscellaneous ASME Vessels

Vessels used for the Plant Air System will be designed and fabricated to meet the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1\(^\text{107}\). The Plant Air vessels will be constructed of 304L stainless steel and have a design pressure of 200 psig. The Plant Air Receiver (TK-501) will be fabricated from carbon steel and will have a design pressure of 150 psig.

The high-pressure back-up purge air receivers (TK-505/506) will be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1\(^\text{107}\), be constructed of carbon steel, and have a design pressure of 3,000 psig.

The Process Water Pressure Tank (TK-305) and the MST Storage Tank (TK-311) are located in the CCA. Both tanks will be constructed of 304L stainless steel, and designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1\(^\text{107}\). The Process Water Pressure Tank has a design pressure of 200 psig and the MST Storage Tank has a design pressure of 15 psig.

11.3.3 Cold Chemicals and Fuel Tanks

Atmospheric tanks used for cold chemicals storage or for plant support systems will be designed and fabricated to American Petroleum Institute (API) 650, Welded Steel Tanks for Oil Storage\(^\text{109}\). Chemical storage tanks will be constructed from 304L stainless steel or other materials that are suitable to maintain structural integrity and corrosion resistance with the stored chemical. All water (PW and DI water) storage tanks will be designed per ANSI/AWWA D100-96, Welded Steel Tanks for Water Storage\(^\text{110}\) or ASTM D1998-06, Standard Specification for Polyethylene Upright Storage Tanks\(^\text{111}\).

The double-wall Diesel Fuel Oil Storage Tank will be designed per NFPA 30, Flammable and Combustible Liquids Code\(^\text{112}\) and Underwriters Laboratory (UL-142), Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids\(^\text{113}\).

11.3.4 Cross-Flow Filters

CFFs are located within the ASDT Cell, SSRT/WWHT Cell, and AFF Process Area. These filters consist of a fixed filter housing, filter tubesheet assembly, and back-pulse tank. The ASP and AFP CFFs will have identical designs, except that the AFP filters will have flanged connections to allow replacement of the entire filter housing. The ASP filter housings are designed to remain within the Process Cell for the entire design life of the SWPF; the tubesheet assembly is designed to be remotely replaced from the Operating Deck. The filter tubesheet assembly seals will be selected to withstand radiation exposure and are designed to be captured in the tubesheet assembly to facilitate replacement.

All pressure-containing components will be designed, fabricated, tested, and stamped per the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1\(^\text{107}\). All wetted parts will be
fabricated from type 316L stainless steel. The ASP filters are designated SS/PC-3 and the AFP filters are designated GS/PC-1. The ASP CFF and support structure will be seismically qualified for PC-3 criteria for position retention and leak tightness per ASCE 4-9874, Section 3.5.4, similar to the PC-3 ASME vessels.

11.3.5 Centrifugal Contactors

Centrifugal contactors are used in the CSSX process. Each contactor is equipped with a variable speed drive to adjust contactor operation to optimize process performance. All wetted parts will be manufactured from type 316L stainless steel. The internal rotor is 10 inches in diameter and shall be a hanging design with an upper seal only. The rotor assembly shall be removable as a single unit, including all normally serviceable parts such as seals and bearings. The contactors will have a CIP feature to rinse all wetted parts to maintain system performance by removing residues that may build up over time. The CIP feature can also be used for in-situ decontamination of the contactor prior to removal.

11.3.6 Process Pumps

Various types of pumps will be used for fluid transfer. Noise level from all pumps shall be minimized (e.g., 85 Decibel A-scale or less at a distance of three ft from the pump) to eliminate the need for hearing protection or limit the areas where hearing protection is required. Additional engineering controls (e.g., sound-deadening materials) may be installed, where appropriate, considering potential for contamination.

With the exception of low shear pumps, all centrifugal process pumps will be designed and fabricated per ASME B73.1, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process114. When solids are present in the pumping fluid, a low shear pump design will be specified. Centrifugal pumps for radiological or concentrated chemical service will be equipped with double mechanical seals or other appropriate seal to minimize potential for leakage. An internal seal flush system will be provided where required as an additional defense-in-depth (DID) to prevent seal leakage of the pumped fluid. Flush Plan 53A, per API 682, Pumps - Shaft Sealing Systems for Centrifugal and Rotary Pumps115, will be used for double mechanical seals. NOTE: API 681 Flush Plan 53A is the same as ANSI B73.1 Mechanical Seal Plan 7353A.

Positive displacement pumps will be specified and designed for specific applications and will be provided with internal or external pressure relief devices to protect downstream components from overpressure. Gear pumps will be internal gear, lobe, external gear, or screw type pumps. These pumps will be designed and fabricated per industry standards. Air diaphragm pumps will be of double-diaphragm, double-acting type. Pumps used in radiological service shall be equipped with containment-type diaphragms that include leak detection to indicate failure of pumping diaphragm. The pump design shall be one-to-one ratio type. Access shall be provided to adjust and replace liquid components including diaphragms, air valves, and other parts that require maintenance.
11.3.7 Mechanical Agitators

Mechanical agitators are used to mix selected AFF and CCA vessels. Agitator components will be designed and fabricated per industry standards. The agitator shaft and impeller will be designed for the life of the facility or will be segmented as required to facilitate installation and removal. Drive assembly shall not allow lubricants to enter the process liquid. Gear boxes shall be designed per American Gear Manufacturers Association (AGMA) 6010/6013 formulas and the name plate horsepower of the motor driver. Mechanical agitators will be seismically qualified, using PC-1 equivalent static methods together with the vessel on which it is mounted.

11.3.8 Heat Exchangers

Shell and tube heat exchangers and condensers will be designed per the ASME Section VIII, Division I\textsuperscript{107} and Tubular Exchanger Manufacturers Association (TEMA) Standards\textsuperscript{116}. Process heat exchangers shall be constructed with stainless steel tubes (304L or 316L).

Plate and Frame heat exchangers shall be designed per the ASME \textit{Boiler and Pressure Vessel Code}, Section VIII, Division I\textsuperscript{107}. Heat exchanger performance will be in accordance with Air-Conditioning and Refrigeration Institute (ARI) 400-2001, \textit{Liquid to Liquid Heat Exchangers}\textsuperscript{117}. Plate and frame heat exchangers shall be gasketed and shall be constructed with stainless steel plates and a carbon steel frame.

11.3.9 Electric Heaters

Electrical heating elements are provided to maintain required process temperatures. The heating element tube sheet/flange and shell shall be designed and fabricated in accordance with the ASME \textit{Boiler and Pressure Vessel Code}, Section VIII, Division I\textsuperscript{107}. All pressure boundary materials shall meet Section II requirements. Welding and brazing qualifications shall comply with ASME Section IX. All electrical heaters located in hazardous areas or flammable environments shall comply with UL-823, \textit{Electric Heaters for Use in Hazardous [Classified] Locations}\textsuperscript{118}.

11.3.10 Filters

Filters provided to remove solid particles in/from selected streams shall be bag or cartridge type. Filter housings shall be designed and fabricated in accordance with the ASME \textit{Boiler and Pressure Vessel Code}, Section VIII, Division I\textsuperscript{107}. Filter housings shall be constructed from 316L stainless steel.

11.3.11 Inline Mixers

In-line mixers are for blending products in the pipe stream and are equipped with flanged ends.
11.4 Plant Support Systems Design Requirements

This section provides the design requirements for the plant air, breathing air, PCHW, plumbing, insulation, and DI Water.

11.4.1 Plant Air and Instrument Air System

Three 50-percent-capacity plant air compressors (CMP-501A/B/C) will supply all plant air and instrument air loads. The compressors will be rotary screw or centrifugal type, with direct-drive electric motors suitable for continuous service. The compressors and coolers will be water-cooled. The cooling water will be circulated through outdoor evaporative coolers. Plant air dryers (DRY 501A/B) will dry all air for the SWPF and designed to provide oil-free air. The dryers consist of desiccant air dryers and after-filters. The air dryers automatically switch to allow regeneration of the desiccant. An air receiver will accommodate system surges and fluctuations in usage.

The primary air system loads are the process vessel APAs. Instrumentation, actuated valves, air driven pumps, and utility stations account for a small portion of the required Plant Air supply. The system shall be designed to accommodate 25% excess capacity for unidentified future use. A high-pressure compressor (CMP-504) and two high-pressure air receivers (TK-505/506) are provided to serve as back-up supply of purge air for hydrogen mitigation in tanks. Quick connection points are also provided for portable engine-driven compressors.

11.4.2 Breathing Air

The Plant Air System will be used to supply breathing air to various locations within the Process Building. Portable point-of-attachment manifolds will be connected to Plant Air utility stations when breathing air is required. The point-of-attachment manifold will be equipped with breathing air filters and instrumentation to monitor the quality of the breathing air. The manifold will also be equipped with a local alarm to notify personnel, should a problem be detected. The functionality of the Plant Air supply is monitored from the CR. The breathing air manifolds will operate on the pressure demand principle to supply constant positive pressure to personnel respirators. The criteria listed in WSRC-TM-95-1, SRS Engineering Standards Manual: Standard No. 11595: Breathing Air Distribution Systems has been considered in the design of the Plant Air System to provide breathing air at the utility stations.

11.4.3 Process Chilled Water System

The PCHW System is designed to maintain the process temperature for optimum performance. PCHW is circulated through a closed-loop system. The PCHW System will consist of a primary/secondary loop system, as shown in Figure 11-1, to provide radiological confinement, prevent leakage of chilled water chemicals (e.g., propylene glycol) into process systems, and preclude any potential radiological decomposition of the glycol.
Figure 11-1. Process Chilled Water System Schematic

The primary system consists of two 100%-capacity Chillers (CHU-005A/B). Each Chiller is served by a separate Supply Pump (P-005A/B) for redundancy. A Bladder Expansion Tank (TK-005) accommodates system temperature-induced expansion/contraction pressure fluctuations. Make-up water for the PCHW System is provided from the PW System and regulated by a pressure control valve. The make-up water line is equipped with a flow switch that is designed to alarm, should excess make-up water flows be detected.

Separate ASP and AFP secondary loop systems are provided. The two separate secondary loop systems provide operational flexibility, radiological isolation within secondary confinement areas, and facilitate pipe routing. Each secondary loop system will consist of:

- Plate and frame exchanger;
- Redundant recirculation pumps;
- Air separator, expansion tank, and chemical feed tank; and
- Radiation monitor to detect potential leaks from process systems.

Make-up water to the secondary loops is from the PW System and regulated by a pressure control valve. The isolation valve for the PW supply will be normally closed to preclude continuous flow of water into a Process System, should a breach in heat transfer equipment occur.

A separate CHWS supplies chilled water to the Process Building and CR AHUs to cool the air supplied by the AHUs through independent systems; see Section 14.5 for HVAC chiller details.
11.4.4 Plumbing

Outside underground DW piping shall be designed, installed, and tested in accordance with AWWA. The DW plumbing inside the SWPF shall be designed, installed, and tested in accordance with the 2003 International Plumbing Code. The SWPF DW System shall also be designed to comply with the Safe Drinking Water Act (SDWA); 40 CFR 141, National Primary Drinking Water Regulations; 40 CFR 142, National Primary Drinking Water Regulations Implementation; and SCDHEC regulations.

Sanitary Sewer piping shall be designed, installed, and tested in accordance with the 2003 International Plumbing Code and SCDHEC requirements. Stormwater mains shall be designed and installed in compliance with ASCE standards. Aboveground stormwater drain pipe shall be designed, installed, and tested in accordance with the 2003 International Plumbing Code.

11.4.5 Insulation and Temperature Maintenance

Asbestos-free mechanical insulation shall be provided, as required, for piping outside cell areas to: minimize energy losses or gains, prevent condensation or freezing and reduce heat loads in areas requiring controlled temperatures, and provide safe surface temperatures for piping and piping components. Mechanical insulation materials, selection, application, design, and installation for piping shall be in accordance with standard industrial practices and guidelines provided in National Commercial and Industrial Insulation Standards Manual (MICA-01) and the National Insulation Association (NIA) mechanical Insulation Design Guide. Thermal insulation and associated materials will exceed the NFPA industrial occupancy flame spread and smoke development ratings specified for areas where the materials are to be installed.

Where applicable, thermal insulation for piping systems and equipment shall be based on the insulation criteria of WSRC-IM-95-58, SRS Engineering Practices Manual, Engineering Guide No. 15250-G (Mechanical Insulation). In conjunction with manufacturer recommendations, insulation materials used on stainless steel surfaces will meet the requirements of ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

Additional provisions, such as heat tracing, are included in the design to maintain required process temperatures. Lines requiring insulation are identified on the Piping and Instrumentation Diagrams (P&IDs).

11.4.6 DI Water Package Unit

The DI Water Package Unit is provided to supply DI water for chemical solution mixing, process chemistry blending, and laboratory service water. The DI Water Package Unit will be supplied from the DW header.
12.0 MATERIAL HANDLING DESIGN

The SWPF is designed to provide shielding and containment of radiological materials. Inaccessible cells are provided as the primary design feature to isolate process vessels. Equipment and components that require maintenance are generally located outside the Process Cells in labyrinths for shielding and accessibility. Items located in the Process Cells that may need to be replaced (e.g., filter tubesheet assemblies, valve internals, cameras, temperature elements) are designed to be accessed and removed from the Operating Deck.

Prior to performing hands-on maintenance activities on a radioactive waste system, the equipment and associated piping are isolated, remotely flushed with clean flush water, and drained to reduce radiation levels to allow contact-handled maintenance. The flushing is also performed to eliminate or reduce contamination levels and hazardous chemical concentrations. The primary contributor to the gamma radiation dose is $^{137m}$Ba, a short-term daughter product of the soluble $^{137}$Cs, which is a component of the salt waste feed from the Tank Farms. Salt waste from the Tank Farms is also anticipated to contain minimal sludges/solids that would pose additional flushing concerns. Information provided in CBU-PIT-2004-00037, Response to Request for Information [RFI]-045: Residual Contamination Levels for Transfer Lines\(^{127}\) shows that radiation levels were undetectable after draining a transfer line used to transfer high-Ci supernate. During the transfer, the radiation level reached 2,500 milliRem (mRem) per hour. Other published documentation related to MCU design also supports the design basis regarding the effectiveness of in situ flushing to sufficiently reduce radiation levels to allow maintenance activities. This documentation includes, but is not limited to, S-ESR-H-00005, Modular Caustic Side Solvent Extraction Unit (MCU) Facility: Radiological Design Summary Report\(^{128}\) and WSRC-STI-2006-00031, Determination of Liquid Film Thickness Following Draining of Contactors, Vessels, and Pipes in the MCU Process\(^{129}\). The current flush strategy, supplemented with temporary shielding to mitigate localized radiation fields associated with “Hot Spots”, is considered to be adequate to reduce residual source terms to allow maintenance activities.

Initial startup/operational information from the ARP/MCU facilities will also be assessed to verify the flushing design basis.

Based on waste characteristics and the operating information provided by the LWO and M&O for salt waste transfers, remote flushing is adopted as the design basis to reduce $^{137}$Cs and residual sludges/solids to levels that would allow contact-handled maintenance. The areas requiring maintenance will be isolated and thoroughly flushed. The residual radiation levels will be progressively measured, using extended hand-held equipment. If radiation levels are excessive, flushing will be repeated and/or the zone of flushing expanded. The flushing system design includes connections for the addition of concentrated HNO$_3$ or caustic solution from the CCA receipt tanks into the flush system. If simple repeat flushing is not successful in reducing radiation levels, more aggressive decontamination/flushing will be performed by blending HNO$_3$ or caustic with the flush water to remove solids buildup. Adding HNO$_3$ or caustic to the flush water system is expected to be an infrequent occurrence. Once gamma radiation levels resulting from residual $^{137}$Cs are reduced ALARA, hands-on maintenance or invasive work will proceed
with containment controls (e.g., glove bags) deployed to prevent the spread of alpha- and/or beta-emitting contamination.

The SWPF has several types of material handling systems that will be used to perform maintenance and/or repair functions, as well as to package and prepare radioactive waste for storage and/or disposal. These material handling systems include bridge cranes, monorails with hoist, Equipment Lift, forklift trucks, handcarts, portable gantry cranes, and battery-operated, manually guided vehicles. This Section describes these material handling systems and some of the functional and/or operational scenarios associated with their use in the SWPF.

12.1 Overhead Handling Systems

1. The following overhead handling systems will be used in the CPA:
   a) Local radio-operated (with remote CR station operating capability) top-running dual girder, 20/7.5/1-ton-capacity overhead electric bridge crane in the Operating Deck;
   b) Manually operated 1-ton – 1.2 ton cranes with chain hoists in the labyrinth area of North and South ASP and CSSX P&VGs.
   c) Manually-operated 700 lb chain hoists on monorails in the Sample P&VG;
   d) Radio-operated 1-ton electric chain hoists on a monorail in the Contactor Operating Deck;
   e) Radio-operated 1/2-ton-capacity under hung bridge crane in the Hot Cell;
   f) Radio-operated 5-ton electric chain hoist on a monorail in the Waste Transfer Access Room;
   g) Radio-operated 2-ton electric chain hoist on a monorail above the CSSX Contactor Drop Area;
   h) Radio-operated 5-ton electric chain hoist on a monorail in the CSSX Tank Cell Operating Deck;

2. The overhead handling system used in the AFF will be a radio-operated, 5-ton-capacity, top-running bridge crane;

3. The overhead handling system located in the FSA includes a radio-operated 15-ton electric wire rope hoist on a monorail in the Truck Bay/Dock; and

4. The overhead handling system located in the CCA includes a radio-operated 1-ton-capacity electric chain hoist on a monorail.

12.1.1 Crane and Monorail Design Requirements

Overhead cranes and monorails shall be procured from commercial manufacturers and will be designed and fabricated in accordance with the applicable portions of the following:
- Crane Manufacturers Association of America (CMAA) No. 70, *Specification for Top Running Bridge and Gantry-type Multiple Girder Electric Overhead Traveling Cranes*[^10];
- NFPA 70[^9] standards; and

12.1.2 Hoist Design Requirements

Hand or electric hoists used for maintenance operations shall be procured from commercial manufacturers and will be designed and fabricated in accordance with the applicable portions of the following:

- ASME B30.16-1999, *Overhead Hoists (Underhung)*[^16];
- ASME HST-2-1999, *Performance Standard for Hand Chain Manually Operated Chain Hoists*[^18]; and

12.1.2 Overhead Crane Operating Conditions

The Operating Deck crane will be used on an as-required basis to replace Alpha Sorption filters, valve internals, and place CCTV camera units in the Process Cells. This equipment can be accessed through sleeved penetrations or by removing shield covers in the Operating Deck. The Operating Deck Bridge Crane can be operated locally, using a radio-control unit or operated remotely from the crane Operator workstation located in the CR. The crane is equipped with multiple cameras and audio notification capabilities to allow remote operations. Because the PBVS is designed to maintain a minimum flow velocity of 125 ft per minute across the opening in the Process Cells with shielded covers removed, the Operating Deck and Operating Deck crane are maintained contamination-free. The Operating Deck crane can also be used to remove the personnel access opening to allow entry into the Process Cells when the process systems have been de-inventoried. Access into the Process Cells is not expected to be required over the facility design life. The personnel access openings will be used during Construction, Cold Commissioning, and D&D.
Crane maintenance will be performed on a contact-handled basis. A small platform accessible by ladder will be located on the east end of the AFF and Operating Deck to access the crane to perform maintenance. A self-propelled Elevated Work Platform will be used to complete maintenance access to the Operating Deck bridge crane. The crane maintenance walkway in the AFF will include a hatched opening to raise/lower AFF replacement components. Additional lifting equipment would be attained from an outside vendor, should any unanticipated major repairs be required.

The Hot Cell will have an underhung bridge crane to support Hot Cell activities. This bridge crane will work within the Hot Cell and, therefore, may become contaminated.

12.1.3 Labyrinth Operating Areas

There are 18 transfer systems in the labyrinth areas of the Process Building. Cranes with hoists and monorails with hoists will be provided in the ASP and CSSX P&VGs and over the Contactor Operating Floor. Monorail and light crane systems are used in these areas because of the limited space and the relatively light loads to be handled.

There are also monorail systems in the Waste Transfer Access Room, CCA, and Truck Bay/Dock serving those respective areas.

12.1.4 ASP Pump and Valve Gallery Cranes

Each labyrinth is served by a crane system. Each crane is equipped with a minimum 1-ton manual chain hoist that will be used for removal/replacement of pumps, valve operators, and other equipment that is either too heavy or has relatively high radiation levels that warrant use of the hoist.

12.1.5 CSSX Pump and Valve Gallery Overhead Lifting Equipment

Each CSSX P&VG labyrinth is served by a overhead lifting equipment system. Six cranes and two monorails will be provided. Each overhead lifting equipment system is equipped with a manually operated chain hoist that will be used to perform the same operations as the ASP P&VG crane hoist.

12.1.6 Contactor Operating Floor Monorail

A monorail with 1-ton electric chain hoists will be used for removal/replacement of contactor motors or contactor internals and lowered onto a cart to transport to the CSSX contactor drop area monorail system.
12.1.7 CSSX Contactor Drop Area Monorail

The CSSX Contactor Drop Area monorail system will lower the removed equipment to Elevation 100'-0", via a removable floor hatch. This monorail is equipped with a 2-ton electric chain hoist that is radio-controlled.

12.1.8 CSSX Tank Cell Operating Deck Monorail

A monorail with a 5-ton electric chain hoist with a radio controller is located in the CSSX Tank Cell Operating Deck above the access opening to the East CSSX Tank Cell. This monorail is provided to facilitate commissioning and to allow a means to remove the shielded cover, should unplanned access into the East CSSX Tank Cell be required.

12.1.9 Waste Transfer Enclosure Monorail

A monorail with a 5-ton electric chain hoist with a radio controller is located in WTE Access Room above the access opening to the WTE. This monorail is provided to facilitate commissioning and allow a means to remove the shielded plug, should unplanned access into the WTE be required.

12.1.10 Truck Bay/Dock Monorail

A monorail with a 15-ton electric wire rope hoist with a pendant controller is located in the FSA Truck Bay/Dock. This monorail is provided to allow loading and unloading of equipment from flat-bed trailers. The monorail/hoist is designed to safely handle an ASP Filter Cask/Pallet assembly with a filter bundle inside.

12.1.11 CCA Monorail

A monorail with a radio-operated 1-ton-capacity electric chain hoist is located in the CCA. This monorail is provided to allow removal/replacement of tank agitator motors. The monorail may be used to lift other equipment (e.g., pumps, heaters, valves) into and out of the containment area.

12.1.12 Drum Off / Decon Area Monorail

A monorail with 1-ton-capacity manual chain hoist is located in the Drum Off/Decon Area to provide lifting and movement of equipment for decontamination.

12.2 Equipment Lift

A 2.5-ton Equipment Lift is provided in the Process Building to service all major floor levels. This Equipment Lift will be used for vertical transport of equipment and HVAC filter cartridges during maintenance and/or repair operations. The Equipment Lift is also used for transporting sample pigs with waste samples received from the Tank Farm to the Analytical Laboratory. The Equipment Lift is not designed to transport personnel.
12.3 Process Cell Equipment Removal/Replacement

The Process Cells are designed with thick reinforced concrete floors, walls, and ceilings. Although access openings are provided, entry into the Process Cells after initiation of Hot Operations is not planned. Components located within the Process Cells that need to be maintained are designed for remote replacement from the Operating Deck. These components include the CCTV camera units, CFF tubesheet assemblies, sleeved isolation and control valve internals, and instrumentation (i.e., temperature elements). Removable shield covers through the Operating Deck floor are provided to gain access to the CFF housings. All other permanently installed components within the Process Vessel Cells and CSSX Tank Cell are designed for the life of the facility, without the need for maintenance or replacement.

12.4 CSSX Contactor Motor Removal/Replacement

It is anticipated that contactor motors and internal bearings will need to be periodically replaced. During operation, the radiation fields are too high to permit manned entry onto the Contacto Operating Deck. The contactors must be de-inventoryed prior to performing contactor maintenance. The de-inventorying process will consist of operating the CSSX process with DSS, which is low in $^{137}$Cs, as the aqueous feed. The contactor CIP system will be used to perform additional internal surface cleaning and/or decontamination. Solids build-up inside the contactors is expected to be minimal because the CSSX feed was processed through the ASP CFFs. If additional de-inventorying is required, each contactor can be individually drained to the SDT. After de-inventorying, manned entry would be allowed for contact-handled maintenance under strict administrative controls.

To facilitate maintenance, all consumable parts (e.g., motors, seals, etc.) on the contactors are accessible from the Contacto Operating Deck. The contactor electric motor and internals removal and replacement are supported by the monorail hoist system above the Contacto Operating Floor at Elevation 124'-0". The electric motor can be removed by unbolting the fasteners. The internals can be removed by unbolting another set of fasteners. The electric motor or internals needing repair will be lifted by the monorail system from the contactor housing and transported to a drop area, where they are loaded into a pre-engineered transport container. This container will shield all wetted internal parts and allow safe transport for personnel and equipment. The components will be transferred to the CSSX contactor drop area monorail. The contactor components will be lowered through the floor opening to a transport cart at Elevation 100'-0" for transport to the Decontamination Area or the Maintenance Shop.

12.5 Process Cell Personnel Access Openings

The Process Cells and in-cell equipment are designed to eliminate the need for access to the cells at any time during the operational life of the SWPF. These cells have no equipment with moving parts or other wear items that would necessitate entry into a Process Cell for maintenance. All other non-removable in-cell components are designed for the life of the plant (40 years). Personnel access openings are provided for each Process Cell. The opening covers are designed to provide radiation shielding and will be sealed prior to initiation of Hot Operations. These
removable covers facilitate equipment/system installation during construction and offer the capability to provide direct access to the in-cell equipment for recovery from an unplanned failure and for final D&D. These covers are removed by use of the 20/7.5/1-ton overhead bridge crane.

12.6 HVAC Equipment Removal/Replacement

Equipment handling in the Exhaust Fan Room will be accomplished with portable lifting equipment and a transport cart. The largest components requiring removal or replacement are the PBVS Exhaust Fans, which weigh approximately 3,700 pounds and are 61” x 22”, and heating/cooling coils from the heat recovery system. The transport cart is moved to the Equipment Lift and lowered to the Controlled Entry Area. The PVVS, PMVS, and PBVS HEPA filter change-outs are manually performed by a bag-in/bag-out operation. Spent filters are then loaded onto a cart and transported to the Equipment Lift.

The Equipment Lift lowers the filters to the Controlled Entry Area for final packaging within the Material Staging and Storage Area for disposal. The packaged filters may be temporarily placed into a Waste Storage Room, pending offsite shipment.

12.7 Process Building Pump, Motor, and Valve Removal/Replacement

Process pumps, motors, and valve operators are located inside shielded labyrinth walls in the P&VG. The process pumps and some valve internals are expected to emit high-radiation fields. The P&VG labyrinth shield walls are designed to provide sufficient shielding to permit access to the ASP and CSSX P&VG corridors during normal plant operations. Each major pump (and its associated valves, piping, and instrumentation) is located inside labyrinth walls.

In order to allow contact-handled maintenance on a pumping circuit, the pump and piping will be isolated, flushed, and drained. The pump flanges and instrument connections will be designed for ease of removal to limit personnel exposure. After uncoupling, the motor and/or pump can be removed by hand or by the crane hoist system.

Contaminated equipment removed from the pump and valve enclosures will be decontaminated locally, or placed in a sealed bag or shielded container before it is moved out of the P&VG. Hand carts will typically be used to move the equipment. Contaminated equipment that has been bagged-out or containerized is moved by cart. These components are moved to the Decontamination Area/Material Staging and Storage Area by hand cart. After additional decontamination, components are moved to the Maintenance Shops, using hand carts.

12.8 Alpha Finishing Facility Pump and Filter Replacement

A 5-ton radio-controlled bridge crane will be used for agitator, filter, and pump maintenance, removal, and replacement. The primary radiation hazard associated with the waste processed in the AFF is alpha radioactivity. Prior to intrusive maintenance activities, the piping/equipment circuit will be isolated, drained, and flushed for system decontamination. All maintenance
activities will be manually performed and containment bags will be used, as required. Equipment will be lifted by the overhead bridge crane to carts on the grate and the concrete floor area located on the eastern end of the AFF. The equipment will be transferred to a hand cart and moved to the Decontamination Area or Maintenance Shop, as required. Failed AFF filters will be sealed and taken to the Truck Bay/Dock for shipment to an offsite disposal facility.

12.9 Material Receipt and Handling Operations

A radio-operated 15-ton-capacity monorail with a 15-ton electric hoist is provided in the Truck Bay/Dock to support truck unloading and loading. A forklift will be provided to transport components and equipment from the Truck Bay/Dock to the Material Staging and Storage Area or Maintenance Shops.

12.10 Compressed Gas Cylinder Handling

Commercially procured hand carts will be used to transport compressed gas cylinder bottles (full and empty) into and out of the Bottle Storage Areas, Laboratory, and Maintenance Shops.

12.11 Cold Chemicals Area

A forklift will be provided in the CCA to assist the day-to-day operations. A drum mixing system is provided for MST mixing, prior to transfer into the MST Storage Tank.

A monorail with a 1-ton radio-controlled electric hoist is provided to remove and install agitator motors from the various chemical storage tanks. Equipment components will be transported by forklift, special lifting device, hand cart, or truck from the CCA Receiving Dock to the Process Building Truck Dock and subsequently transferred to the appropriate Maintenance Shop in the EFSA.

12.12 Analytical Laboratory Sample Handling

Material handling is required for the Analytical Laboratory to collect samples from various process vessels and prepare these samples for analytical analyses. The sample fluids will be pumped through individual recirculation loops that are routed to the laboratory. Samples will be transferred between glovebox lines, using the Sample Transfer System (STS). The STS will be a self-propelled sample carrier that is attached to a rail system. The sample carriers are powered from the rail system, using low-voltage Direct Current (DC). The STS will be enclosed. Glove ports will provide a designated location for maintenance or repair of the sample carriers. Sampling devices will be used to draw off representative samples from the recirculating fluid. Up to 100 sample aliquots will be processed and analyzed within the laboratory each day. The sample handling system is designed to minimize risk for radiological contamination, efficiently transfer samples between the various analytical stations, and minimize the labor dedicated to sample transfers and radiological control oversight.
Equipment used to collect high-Ci samples from the ASP and CSSX process vessels is located within a shielded Hot Cell to protect laboratory workers. These high-Ci samples are pumped through individual recirculating loops that are routed to the Hot Cell and will be divided into small aliquots, diluted, and/or processed within the Hot Cell to allow contact-handling to be performed in subsequent analyses. The Hot Cells are equipped with master-slave manipulators and a 0.5-ton underhung bridge crane. The manipulators will be designed to provide the dexterity, reach, and interaction required to accomplish sample handling and maintenance tasks within the Hot Cells. The overhead bridge crane will be used for lifting equipment and items that are too heavy for the manipulators.

Analytical instruments and aliquot transfer equipment are contained within Hot Cells, gloveboxes and radio hoods to provide confinement of potential airborne radioactive contaminants. Gloveboxes will be designed based on the guidelines presented in AGS-G001-1998, *Guidelines for Gloveboxes*[^140] from the American Glovebox Society. The gloveboxes and radio hoods will be designed to allow O&M of the analytical instruments.

### 12.13 Analytical Laboratory Hot Cell CCTV Removal / Insertion

CCTVs in the laboratory area are inserted by using an insertion/removal device. The manual operation of removing the shield plug, sliding out the carrier sideways to line up the camera unit, and pushing the camera unit into the wall penetration is relatively simple. Removal of the camera unit requires bagging of the camera end of the camera unit. The camera will be separated from its unit housing in a controlled decontamination area.

### 12.14 Mechanical Room Equipment Removal

Chilled water and heat recovery water pumps will be installed for the HVAC system in the Mechanical Room. A portable crane and hand cart (or combination of the two) will be provided for pick-up and placement of the pumps onto the cart. The portable crane and cart system (or a combination of the two) will also be used for the removal and transport of filters, coils, motors, and dampers associated with the AHUs.

### 12.15 Electrical Room Equipment Removal

Electrical Rooms house the modular switchgear enclosures and MCCs. Electrical equipment will be removed for maintenance or replacement by using the portable crane or forklift. In the unplanned failure of electrical equipment that cannot pass through doors and corridors, external wall panels would be removed/cut to gain access to replace the equipment. Structural bracing along the exterior wall will be configured to facilitate equipment removal.

### 12.16 Other Material Handling Equipment

Other material handling equipment including hand-operated loading dollies, carts, grapple devices, and pallet jacks shall be procured as commercial-grade items and do not require specific design standards.

[^140]: Guidelines for Gloveboxes, American Glovebox Society.
13.0 PIPING DESIGN

Process piping will be designed, installed, and tested in accordance with ASME B31.3-2002, *Process Piping*\(^{141}\). DW piping will be designed to meet the requirements of ASME B31.3-2002, ANSI/AWWA C900-97, *Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution*\(^{142}\), or International Plumbing Code (IPC) 2003, *International Plumbing Code*\(^{143}\), as required, based on location. All piping design will be based on the approved P&IDs.

13.1 Fluid Services

The fluid services identified for the SWPF process and utilities system are listed in Table 13-1.

13.2 Piping Materials Specifications

The piping material specifications used and their applicability to the fluid services are shown in Table 13-2. Each specification contains an array of fittings, end preps, valves, bolts, and gaskets and incorporates the requirements of ASME B31.3-2002\(^{141}\), ANSI/AWWA C900-97\(^{142}\), and IPC 2003\(^{143}\).

### Table 13-1. Service Description

<table>
<thead>
<tr>
<th>Fluid Codes</th>
<th>Service Description</th>
<th>Pipe Class (Ps-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AQU</td>
<td>AQUEOUS SALT SOLUTION</td>
<td>200C, 202C, 200D, 200F</td>
</tr>
<tr>
<td>AR</td>
<td>ARGON</td>
<td>200A, 200D, 202A, 202D</td>
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<tr>
<td>BA</td>
<td>BREATHING AIR</td>
<td>102B, 200A, 202A</td>
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<tr>
<td>COND</td>
<td>CONDENSATE</td>
<td>200A, 200C, 202A, 202C</td>
</tr>
<tr>
<td>CWS/CWR</td>
<td>CHILLED WATER</td>
<td>102B, 200C, 202C, 103B, 200A, 202A</td>
</tr>
<tr>
<td>DHW</td>
<td>DOMESTIC HOT WATER</td>
<td>200A, 200C, 400</td>
</tr>
<tr>
<td>DI</td>
<td>DEIONIZED WATER</td>
<td>200A, 200C, 202A, 202C</td>
</tr>
<tr>
<td>DIES</td>
<td>DIESEL FUEL</td>
<td>102B</td>
</tr>
<tr>
<td>DR</td>
<td>DRAIN OR PROCESS DRAIN</td>
<td>200A, 102B, 200C, 200D, 905, 202C, 202D, 200F, 202A</td>
</tr>
<tr>
<td>DR</td>
<td>DRAIN – NON-PROCESS UNDERGROUND</td>
<td>905</td>
</tr>
<tr>
<td>DS</td>
<td>DUCT SAMPLE</td>
<td>200A</td>
</tr>
<tr>
<td>DSS</td>
<td>DECONTAMINATED SALT SOLUTION</td>
<td>101C, 200C, 202C</td>
</tr>
<tr>
<td>DW</td>
<td>DOMESTIC WATER</td>
<td>200A, 400, 202A, 200C</td>
</tr>
<tr>
<td>DW (UG)</td>
<td>DOMESTIC WATER (UNDERGROUND)</td>
<td>903, 200C</td>
</tr>
<tr>
<td>FLU</td>
<td>FLUSH WATER</td>
<td>200D, 202D, 200C</td>
</tr>
<tr>
<td>FP</td>
<td>FIRE PROTECTION (UNDERGROUND)</td>
<td>904, 906</td>
</tr>
<tr>
<td>FP</td>
<td>FIRE PROTECTION (ABOVEGROUND)</td>
<td>908</td>
</tr>
<tr>
<td>HEL</td>
<td>HELIUM</td>
<td>200A, 200D, 202A, 202D</td>
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<tr>
<td>HLW</td>
<td>HIGH LEVEL WASTE FEED</td>
<td>200D, 202D, 101C</td>
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<tr>
<td>HYD</td>
<td>HYDROGEN</td>
<td>200D, 202D</td>
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### Table 13-1. Service Description (cont.)

<table>
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<tr>
<th>Fluid Codes</th>
<th>Service Description</th>
<th>Pipe Class (Ps-)</th>
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<tbody>
<tr>
<td>HN03</td>
<td>NITRIC ACID</td>
<td>200D, 202D, 200C</td>
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<tr>
<td>HRWS / HRWR</td>
<td>HEAT RECOVERY WATER (SUPPLY &amp; RETURN)</td>
<td>102B, 103B</td>
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<tr>
<td>HYPO</td>
<td>SODIUM HYPOCHLORITE (12% BLEACH)</td>
<td>501</td>
</tr>
<tr>
<td>IA</td>
<td>INSTRUMENT AIR</td>
<td>102B</td>
</tr>
<tr>
<td>INST</td>
<td>INSTRUMENT</td>
<td>200D, 202D, 200A</td>
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<tr>
<td>JKT</td>
<td>JACKETED PIPE</td>
<td>101C, 200H</td>
</tr>
<tr>
<td>LRW</td>
<td>LIQUID RADIOACTIVE WASTE</td>
<td>200D, 202D</td>
</tr>
<tr>
<td>MST</td>
<td>MONOSODIUM TITANATE</td>
<td>200D, 202D</td>
</tr>
<tr>
<td>NAOH</td>
<td>CAUSTIC SOLUTION</td>
<td>200D, 202D</td>
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<tr>
<td>NI</td>
<td>NITROGEN</td>
<td>200A, 200D, 202A, 202D</td>
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<tr>
<td>OXA</td>
<td>OXALIC ACID / NITRIC ACID</td>
<td>200D, 202D</td>
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<tr>
<td>PCWS / PCWR</td>
<td>PROCESS CHILLED WATER (SUPPLY/RETURN)</td>
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<td>PEN</td>
<td>PENETRATIONS SLEEVES</td>
<td>200P</td>
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<tr>
<td>PHWS/PHWR</td>
<td>PROCESS HOT WATER (SUPPLY/RETURN)</td>
<td>200C</td>
</tr>
<tr>
<td>PMV</td>
<td>PULSE MIXER VENT</td>
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<tr>
<td>PROP</td>
<td>PROPANE</td>
<td>200A, 200D, 202A, 202D</td>
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<td>PROCESS VESSEL VENT</td>
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<td>SHW</td>
<td>SERVICE HOT WATER</td>
<td>200A, 200C, 202A, 400</td>
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<tr>
<td>SLU</td>
<td>SLURRY / SLUDGE</td>
<td>200C, 200D, 202D</td>
</tr>
<tr>
<td>SOL</td>
<td>SOLVENT</td>
<td>200C, 200D</td>
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<tr>
<td>SOLW</td>
<td>SOLVENT WASTE</td>
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<td>SSEW</td>
<td>SAFETY SHOWER EYEWASH</td>
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<td>STM</td>
<td>STEAM, 100 PSIG</td>
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<td>SW</td>
<td>SERVICE WATER</td>
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<tr>
<td>TRIM</td>
<td>VESSEL PUMP TRIM</td>
<td>ALL CLASSES</td>
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# Table 13-2. Application of Fluid Services

<table>
<thead>
<tr>
<th>Piping</th>
<th>Material</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS101C</td>
<td>Carbon Steel, Class 150, 0.063-inch Corrosion Allowance</td>
<td>JKT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DSS</td>
</tr>
<tr>
<td>PS102B</td>
<td>Carbon Steel, Class 150, 0.03-inch Corrosion Allowance</td>
<td>IA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CWS/CWR</td>
</tr>
<tr>
<td>PS200A</td>
<td>304L Stainless Steel, Class 150/300, 0.00-inch to 0.05-inch Corrosion Allowance</td>
<td>AR, DHW</td>
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<tr>
<td>PS202A</td>
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<td>BA, DR</td>
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<tr>
<td></td>
<td></td>
<td>CWS/CWR</td>
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<tr>
<td></td>
<td></td>
<td>COND, PVV</td>
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<tr>
<td></td>
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<td>DI, SHW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DW</td>
</tr>
<tr>
<td></td>
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<td>HEL, VENT</td>
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<td></td>
<td></td>
<td>NI, INST</td>
</tr>
<tr>
<td>PS200C</td>
<td>304L Stainless Steel, Class 150/300, 0.05-inch Corrosion Allowance</td>
<td>AQU, COND</td>
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<tr>
<td>PS202C</td>
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<td>DI, FLU</td>
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<tr>
<td></td>
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<td>DR, DHW</td>
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<td></td>
<td></td>
<td>DSS (non slurry)</td>
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<td></td>
<td></td>
<td>VENT, TRIM</td>
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<td></td>
<td></td>
<td>CWS/CWR, PW</td>
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<td></td>
<td></td>
<td>SW</td>
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<tr>
<td>PS200F</td>
<td>304L Stainless Steel, Class 150, 0.08-inch Corrosion Allowance</td>
<td>AQU (Underground Sump Piping), DR</td>
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<td>SSEW, VENT, TRIM</td>
</tr>
<tr>
<td>PS200D</td>
<td>304L Stainless Steel, Class 150/300, 0.08-inch Corrosion Allowance (includes erosion allowance for slurry service)</td>
<td>AR, LRW</td>
</tr>
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<td>PS202D</td>
<td></td>
<td>DR, AQU</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FLU, SW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HEL, PW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HLW, TRIM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HNO₃, JKT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HYD, TRIM</td>
</tr>
<tr>
<td>PS400</td>
<td>Copper Tubing, Type L, 0.00-inch Corrosion Allowance</td>
<td>DW (non-process areas), DHW, SHW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSEW, TRIM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW</td>
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<td>PS501</td>
<td>CPVC, Class 150, 0.00-inch Corrosion Allowance</td>
<td>HYPO</td>
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<td>PS903</td>
<td>Ductile Iron, 200 psig Pressure Rating</td>
<td>DW (outside underground)</td>
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<tr>
<td>PS904</td>
<td>Ductile Iron, Cement Lined, Class 125, 0.00-inch Corrosion Allowance</td>
<td>FP (Underground, to outside of Process Building)</td>
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<tr>
<td>PS905</td>
<td>PVC, Class 125, 0.00-inch Corrosion Allowance</td>
<td>DR (Non-process drains, underground)</td>
</tr>
</tbody>
</table>
Table 13-2. Application of Fluid Services

<table>
<thead>
<tr>
<th>Material Code</th>
<th>Description</th>
<th>Service Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS906</td>
<td>PVC, AWWA C900, 0.00-inch Corrosion Allowance</td>
<td>FP (Underground)</td>
</tr>
<tr>
<td>PS908</td>
<td>Carbon Steel/Copper, 0.00-inch Corrosion Allowance</td>
<td>FP (Above ground, inside Process Building)</td>
</tr>
<tr>
<td>PS103B</td>
<td>CARBON STEEL, CLASS 300, 0.05 INCH CORROSION ALLOWANCE</td>
<td>CWS/CWR, PCWS/PCWR, PA, HRWS/HRWR, TRIM</td>
</tr>
<tr>
<td>PS108B</td>
<td>CARBON STEEL, CLASS 1500, 0.03 INCH CORROSION ALLOWANCE</td>
<td>PA, TRIM</td>
</tr>
<tr>
<td>PS200H</td>
<td>304 STAINLESS STEEL, CLASS 150, 0.00 CORROSION ALLOWANCE</td>
<td>JKT (ENCLOSURE OUTER CONTAINMENT PIPE)</td>
</tr>
<tr>
<td>PS200P</td>
<td>CARBON STEEL</td>
<td>PEN (WALL OR FLOOR PENETRATIONS)</td>
</tr>
</tbody>
</table>

13.3 Piping Requirements

Piping runs under positive pressure shall have capability for venting, draining, and refilling. Piping design shall incorporate drain and flush capability for process vessels/piping to support line break operation. Embedded process piping shall be designed for the life of the facility. Welds in embedded process piping shall be subject to 100% volumetric (radiographic or ultrasonic) and 100% visual examinations.

Embedded process piping is generally associated with wall and floor penetrations. Pipe spools are designed to avoid weld seams being located within the embedded portion of the penetration. Welds associated with the shielded sleeve valve assemblies are considered embedded process piping.

Embedded drains are included in the design to provide containment for off-normal events such as a leak, fire water discharge, or safety shower activation, and for draining piping systems and equipment. These gravity drains are infrequently used, not pressurized, and located within the basemat of the PC-3 structure, which will provide gross drainage (with or without pipe integrity) following a seismic event. As such, the embedded gravity drain welds will be subject to a minimum 5% volumetric examination with 100% visual examination.

The West WTL core pipes will be examined and tested as an embedded process pipe. The core pipe welds will be subject to 100% volumetric and 100% visual examinations. The welds associated with West WTL jackets and DSS WTL core pipes and jackets will be subject to a minimum 5% volumetric examination and 100% visual examination.

Welds for all piping systems located within an inaccessible Process Cell shall be subject to 100% volumetric and 100% visual examinations. The inaccessible Process Cells include the SSFT Cell, SEHT Cell, AST-A Cell, FFT-A Cell, ASDT Cell, SSRT/WWHT Cell, the East CSSX Tank Cell, and WTE.

ASME B31.3 piping will be designed and examined per their designated Fluid Service. Piping will be normal fluid service except when designated as Category D. Examination frequency will
be increased via progressive sampling in response to identified defects in accordance with ASME B31.3 Requirements. Lines may be classified as Category D fluid Service if they meet the criteria in items 1 through 3, as governed by the additional implementation requirements outlined in items 4 through 7:

1) Lines meet the requirements of ASME B31.3 300.2, Category D fluid service. Specifically:
   a) The fluid will be nonflammable, nontoxic, and not damaging to human tissues;
   b) The design gage pressure will not exceed 150 psig; and
   c) The design temperature will be from -20°F to 366°F.

2. Lines are only in the following piping service code systems [piping covered by other codes and standards (e.g., Uniform Plumbing Code) will be covered by those codes and standards].
   d) AR – Argon
   e) CWR – Chilled Water Return
   f) CWS – Chilled Water Supply
   g) DHW – Domestic Hot Water
   h) DI – Deionized Water
   i) DS – Duct Sample
   j) DW – Domestic Water
   k) HEL – Helium
   l) HRWR – Heat Recovery Water Return
   m) HRWS – Heat Recovery Water Supply
   n) INST – Instrument
   o) NI – Nitrogen Gas
   p) PA – Plant Air
   q) PCWR – Process Chilled Water Return
   r) PCWS – Process Chilled Water Supply
   s) PHWR – Process Hot Water Return
   t) PHWS – Process Hot Water Supply
   u) PW – Process Water
   v) VENT – Building Ventilation and Service Vents

3. Lines are in piping used only for non-radioactive service.

4. Lines meeting criteria 1 through 3 that terminate in inaccessible areas in the CPA (Process Vessel Cells, Waste Transfer Enclosure, East CSSX Tank Cell, and HVAC shielding chase)
will remain normal fluid service up to the first isolation point outside the inaccessible area. They will continue to have 100% volumetric nondestructive examination within the inaccessible areas.

5. Lines meeting criteria 1 through 3 in inaccessible areas in the CPA (Process Vessel Cells, Waste Transfer Enclosure, East CSSX Tank Cell, and HVAC shielding chase) that do not terminate in the inaccessible areas will be Category D but will continue to be fabricated and examined in accordance with Normal Fluid Service acceptance criteria and within the inaccessible areas they will receive 100% volumetric nondestructive examination. As Category D they may be leak tested via initial service inspection in lieu of a hydrostatic/pneumatic test. The initial service inspection leak test will use constrained flow versus free flow conditions so that the leak test occurs at an elevated pressure within the normal operating range.

6. Lines meeting criteria 1 through 3 in the CPA outside of inaccessible areas (Process Vessel Cells, Waste Transfer Enclosure, East CSSX Tank Cell, and HVAC shielding chase) may be Category D but will continue to be fabricated and examined in accordance with Normal Fluid Service acceptance criteria and receive 5% random volumetric examination. As Category D they may be leak tested via initial service inspection in lieu of a hydrostatic/pneumatic test.

7. Lines meeting criteria 1 through 3 outside of the CPA may be Category D with no supplementary requirements. Specifically, they may be fabricated and examined in accordance with Category D acceptance criteria and may be leak tested via initial service inspection in lieu of a hydrostatic/pneumatic test.

Process Cell process piping will be routed with a minimum of 1/16-inch per ft of slope to allow free draining of the process systems as indicated on P&IDs. Process piping with less than 1/16-inch per ft of slope located in Process Cells (specifically rooms SSFT Cell, SEHT Cell, AST-A Cell, FFT-A Cell, ASDT Cell, and SSRT/WWHT Cell) shall be reviewed/approved by the Design Authority. Five diameter bends will be used for slurry lines within the Process Cells to minimize the effects of erosion. When using 5D, bends are precluded by physical routing limitations or stress analysis, 1.5D elbows may be used with the approval of Material Engineering. Process Cell piping will be routed to avoid or minimize the number of penetrations through the stainless steel liner. Where piping penetrates the liner, the pipe will be seal-welded to the liner and visually, surface, and volumetrically examined in accordance with the requirements of ASME B31.3-2002. All piping joints/connections, whether pipe-to-pipe or pipe-to-equipment, shall meet the service class. All valves placed inside the Process Cells will be furnished with remote operators.

Waste transfer piping outside the Process Building will be routed underground, with required slope to drain back to the LWO facilities. Waste lines will be jacketed for containment and detection, in the unlikely event of a leak from the inner process piping.

13.4 Pipe Supports

Pipe supports and restraints shall be analyzed in accordance with ANSI/ American Institute of Steel Construction, Inc.(AISC) N690-94 (R2004), Specification for the Design, Fabrication, and

### 13.5 Piping Systems Structural Integrity Analyses

Piping stress analysis will be performed, based on the criteria and methods identified in G-ESR-J-00002, *Piping Systems Structural Integrity Acceptance Criteria*. The piping systems structural integrity evaluations shall consider the effects of internal pressure, hydrostatic test loads, dead loads, soil pressure loads, live loads, wind loads, earthquake loads, self-limiting loads, other dynamic loads, and cyclic loads as defined in ASME B31.3-2002, as applicable. Further, the piping system structural integrity evaluations shall also consider the effects of earthquake loads, as defined in ASME B31.3-2002, and the combination of the component seismic loads, as outlined in DOE-STD-1020-2002. The seismic analysis criteria are specific to the PC (i.e., PC-1, PC-2, or PC-3) assigned to each respective piping system.

### 13.6 Plant Design System 3-D Modeling and Summary Information

Plant Design System (PDS) 3D Modeling will be used to model SWPF.

#### 13.6.1 Material Take-off

PDS writes to a database that will list all components and fittings categorized by part number. This database can be accessed by the Document Materials Control System to provide a complete materials list.

#### 13.6.2 Line Summary Report

A line report will provide a complete description of each line in the piping system. The list will provide site area, service, line number, pipe specification, insulation, from and to, fluid type (L, V, M), Operating flow (min/max), design pressure, design temperature, density, minimum test pressure, operation pressure (min/max), operating temperature (min/max), P&ID number, and remarks.
13.6.3 Valve List

A complete valve list will be created for each valve and will include the sequence number, Service Symbol, valve type, size, end connection, Drawing number, and valve code.

The valve list only identifies process bulk item valves. It does not include instrument- or power-operated valves identified by an instrument balloon.

14.0 HVAC DESIGN

Ventilation systems for the Process Building include the main PBVS, AFF ventilation system, and CCA ventilation system. The HVAC design consists of systems to control building temperature and humidity. In areas where radiological materials are processed, the building ventilation is designed to provide confinement of potential airborne radioactive contaminants. The radioactive particles are captured onto HEPA filters prior to discharging the exhaust air to the atmosphere.

All ventilation systems for the Process Building, except for the CR, are designed for once-through air supply/exhaust without recirculation of internal building air. Outdoor supply air is drawn into AHUs through building wall louvers for pre-filtering and conditioning. Cooling for all the AHUs, except for the CR AHU, is provided from a common CHWS. CR cooling is provided by separate dedicated chillers. Distribution pumping for the chilled water is located within the FSA Mechanical Room. The SSP Room has a dedicated heat pump.

Air flow within the CPA portion of the Process Building is cascaded from areas that have the lowest potential for contamination to areas with the highest potential to become contaminated. The cascaded air is then exhausted from the cell areas through the exhaust HEPA filters. For the AFF, all building air is exhausted from the main process area through separate HEPA filters.

The filtered air from both the CPA and AFF is directed to an Exhaust Stack that will be monitored to ensure that the filtration equipment is operating properly. In the event of power loss, the exhaust fans for the PBVS will be powered from the D/G. Other portions of the ventilation system, including the AHUs and building chillers, are not powered from the D/G. Although building temperature and humidity may fall outside specified design values under loss of power, confinement within the Process Building would be maintained.

A separate ventilation system is provided for the CR that allows the CR to be isolated from the PBVS. The CR ventilation is a recirculating air system and has redundant AHUs and chillers. The CR ventilation system (i.e., AHU fans, AHU heating coils, and chiller units/pumps) is provided with standby power from the D/G if the normal power supply is interrupted.

Two dedicated ventilation systems are provided for process equipment located within the CPA. The PVVS is designed to maintain process vessels and equipment under a slight vacuum, relative to the room/cell pressure. The vented air is cooled to condense vapors and then filtered to remove any particulates, prior to being combined with the Process Building exhaust. Both the
PVVS and PMVS are provided with standby power from the D/G. Process vessels located within the AFF are passively vented to the building exhaust through a HEPA filter.

Separate ventilation systems are provided for the CCA, Compressor Building, D/G, and Administration Building. These systems are designed to provide general building ventilation and temperature control. Other than internal ventilation systems required for D/G operations, ventilation systems for the AFF, CCA, Compressor Building, and Administration Building are not provided with standby power.

14.1 Radiological Confinement Design Requirements

Absolute physical confinement is impractical for nuclear facilities because of the requirement to provide for personnel/equipment access, in addition to penetrations for services and waste products. The SWPF confinement philosophy is based on using barriers and other physical design features to confine the materials or processes. The barriers are designed as confinement zones of progressively lesser contamination potential until the external environment is reached. This confinement zone approach is presented in DOE-HDBK-1169-2003, *Nuclear Air Cleaning Handbook* and has been adopted for the SWPF.

The confinement design is based on three zones. Zone 1 areas have the greatest radiological consequences, should an airborne release occur. Zone 2 areas are less likely to become contaminated, and Zone 3 areas do not normally contain radiological materials. The exhaust system is designed to maintain a cascading air flow from Zone 3 to Zone 2 and, finally, into Zone 1 areas.

The Primary Confinement Zone, designated as Zone 1, consists of the six Process Cells, the East and West CSSX Tank Cells, WTE, Analytical Laboratory gloveboxes (including transfer conveyor/enclosure), and Hot Cell.

The Secondary Confinement Zone, designated as Zone 2, includes those areas that are ordinarily free of contamination, but have the potential for being contaminated. The Secondary Confinement Zone includes, but is not limited to, the Operating Deck, Material Staging and Storage Area, ASP P&VG, CSSX P&VG, Contactor Support and Operating Floors, CSSX Contactor Drop Access Area, Drum Off / Decon Area, Cell Inlet HEPA Filter Rooms, Analytical Laboratory (including radio hoods), PVVS/PMVS and Laboratory Vent Room, and Process Building Exhaust HEPA Filter Room. To further minimize the potential dispersion of airborne radiological materials, supply air vents are located within access corridors and the air is exhausted from areas in which radiological materials are present (e.g., labyrinths).

The Tertiary Confinement Zone, designated as Zone 3, is the final barrier to prevent the release of airborne hazardous materials to the environment. These areas are generally located at the entry control points into the Radiological Control Area boundary. The Tertiary Confinement Zone includes, but is not limited to, the Controlled Entry Area, Process Building Exhaust Fan Room, Clean HEPA Filter Storage and Staging Area, PVVS/PMVS Fan Room and Staging Area,
FSA Maintenance Shops, HP Support Area, Truck Bay/Dock, Administrative Areas, and Locker Rooms.

In addition to the ventilation system confinement boundaries, the PVVS is designed to maintain waste processing systems under negative pressure, relative to the surrounding room pressure. As such, the PVVS provides an additional confinement mechanism that maintains air leakage into process systems.

14.2 General HVAC Design Requirements

The external environmental design conditions for the SWPF are based on data for Augusta, Georgia (the nearest city to Aiken, South Carolina that is listed), published on pages 27.10 and 27.11 of the 2001 ASHRAE Fundamentals Handbook. These published values represent the range of atmospheric conditions under which HVAC systems are normally expected to operate. The summer and winter design conditions are:

- **Summer**: 94°F dry-bulb (1%), 76°F wet-bulb, and 20.2°F mean daily range; and
- **Winter**: 25°F dry-bulb (99%).

The summer external dry-bulb temperature can be expected to exceed 94°F for 1% of the total hours during the months from June through September. The coincident wet-bulb temperature indicated above is the mean of all wet-bulb temperatures occurring at the specific dry-bulb temperature. The winter external temperature is expected to be above 25°F for 99% of the total hours in the months of December, January, and February.

The design temperature and humidity requirements are listed in Table 14-1. The design building space temperature and humidity requirements are based on the expected occupancy, processing needs, and environmental qualification requirements for equipment.

All HVAC supply and exhaust systems are sized to maintain temperature in each building area between the design minimum and maximum values, considering external environmental design conditions and projected heat loads. Heat loads considered for HVAC component sizing include, but are not limited to, the following:

- Process equipment (e.g., heat exchangers, vessels, piping);
- Mechanical equipment (e.g., motors for pumps, cranes, agitators, etc.);
- Instrumentation and Controls (I&C) panels and UPS (e.g., battery chargers, inverters, etc.);
- Lighting (e.g., in-cell CCTV, lights, general area lighting, and special task lighting);
- General office equipment (e.g., computers, reproduction equipment, etc.);
- Solar gains through the building envelope;
- Outside air cooling load, including infiltration through the building envelope;
- Electrical distribution equipment (transformers, MCCs); and
- Mission-specific heat-emitting equipment.

**Table 14-1. Interior Building Design Temperature and Humidity Requirements**

<table>
<thead>
<tr>
<th>Area</th>
<th>Minimum Winter Temperature (°F)</th>
<th>Maximum Summer Temperature (°F)</th>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normally Unoccupied Areas*</td>
<td>60</td>
<td>90</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Inaccessible Zone 1 Areas (CPA Process Cells, and CSSX Tank Cells)*</td>
<td>60</td>
<td>95</td>
<td>Non-Condensing***</td>
</tr>
<tr>
<td>Electrical and Mechanical Rooms*</td>
<td>60</td>
<td>95</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>General Maintenance Area (Maintenance and Shops)**</td>
<td>60</td>
<td>78</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Material Staging Area, Maintenance and Storage Area**</td>
<td>60</td>
<td>78</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>CCA</td>
<td>60</td>
<td>78</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Laboratories</td>
<td>72</td>
<td>78</td>
<td>&lt;60</td>
</tr>
<tr>
<td>CR and SSP Room</td>
<td>72</td>
<td>78</td>
<td>&lt;60</td>
</tr>
<tr>
<td>UPS Room and IT Equipment Room*</td>
<td>72</td>
<td>78</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Administrative Areas**</td>
<td>68</td>
<td>78</td>
<td>Non-Condensing</td>
</tr>
<tr>
<td>Compressor Building</td>
<td>60</td>
<td>100</td>
<td>None Specified</td>
</tr>
<tr>
<td>D/G Enclosure</td>
<td>Per Manufacturer’s Requirements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
* Based on P-ESR-J-00011\(^2\).
*** Condensation is allowed on surface of process tanks in dark cells.

The minimum air change requirements for designing each confinement zone for the SWPF are provided in Table 14-2 and are based on DOE-HDBK-1169-2003\(^\text{150}\). Although the Operating Deck is identified as a Zone 2 confinement area, the required minimum number of air changes was reduced to four air changes per hour, due to the large volume of the Operating Deck. The reduced number of air changes provides adequate flow to maintain containment flows into the Process Cells during normal maintenance activities and unplanned events that require entry into a Process Cell.

The Process Building AHUs and Exhaust System are designed to maintain a dP between ventilation confinement zones, as shown in Table 14-3. Requirements for dP design for the SWPF confinement zones are also based on DOE-HDBK-1169-2003\(^\text{150}\). The SWPF design dP between Zone 2 and 1 is -2.7 inches water gauge (except the gloveboxes which are designed at a
minimum of -0.3 inches water gauge), in order to draw the air from Zone 2 to Zone 1 through the Cell Inlet Air HEPA filters, which may reach -2.0 inches water gauge when dirty.

**Table 14-2. Design Air Change Requirements**

<table>
<thead>
<tr>
<th>Confinement Zone</th>
<th>Minimum Air Change Per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10**</td>
</tr>
<tr>
<td>2</td>
<td>6*</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes:
- * 4 air changes per hour for Operating Deck
- ** Does not apply to the WTE

**Table 14-3. Design Differential Pressure Requirements**

<table>
<thead>
<tr>
<th>Confinement Areas</th>
<th>Minimum dP Requirement (inches water gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 to Zone 2</td>
<td>-2.7*,**</td>
</tr>
<tr>
<td>Zone 2 to Zone 3</td>
<td>-0.15</td>
</tr>
<tr>
<td>Zone 3 to Atmosphere</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

Notes:
- * Based on maintaining adequate air flow and negative pressure in Zone 1, with pressure drop across cell inlet air HEPA filters of 1.0 to 1.5 inches water gauge.
- **Except the gloveboxes which are designed at a minimum of -0.3 inches water gauge referenced to the room containing the glovebox.

As described in S-SAR-J-00001, the PBVS is a credited confinement system for preventing significant exposure to onsite workers. The prefilters and HEPA filters also maintain radiological emissions ALARA, as required by DOE O 5400.5, *Radiation Protection of the Public and the Environment*. Radionuclide emissions from the SWPF will not exceed an amount that would cause any member of the public to receive an effective dose equivalent greater than 0.1 mRem/yr. The SWPF is, therefore, exempt from permitting and treatment requirements pursuant to 40 CFR 61.96(b), *Applications to construct or modify*. Non-radiological emissions of toxic and criteria pollutants will be designed to be below levels of regulatory concern. Therefore, neither a permit nor pollution control systems are required under SCR 61-62, *Air Pollution Control Regulations and Standards*. 
The PBVS exhaust system components that perform a pressure boundary confinement function (e.g., ductwork, filter housings, fan housings) are designated SS/PC-1 from the intake of the exhaust duct to the exhaust duct penetration at the CPA exterior wall. Selected inlet and exhaust air HEPA filters, dP transmitters, flow elements, exhaust fan motors, and flow control dampers are also designated SS. All remaining HVAC components, including but not limited to, instrumentation, interlocks, radiation monitors, and isolation dampers are designated GS/PC-1. The PBVS exhaust fans are powered from the Standby Bus MCCs. UPS power panels supply power to the Continuous Air Monitoring (CAM) System.

14.3 Process Building Ventilation System Design

The confinement of potential airborne radioactive contaminants is the primary design objective for the PBVS. The waste streams handled by the ASP and CSSX process pose the highest risk for external radiation exposure and radiological contamination. The CPA is designed with thick-concrete-walled cells to provide shielding from radiation sources, while still allowing access to equipment and components for maintenance. The process vessels and associated piping are designed as the primary confinement boundary to prevent release of radiological materials that would exceed dose consequence limits.

Although the PBVS is not relied upon to operate following an NPH event, the PBVS provides SS functions for confinement in the event of a spill, leak, or other operational failure. The ventilation system was merged with the physical design of the CPA to preclude wide-spread migration of potential airborne radiological contamination. The goal of this confinement design is to minimize the potential of internal exposure, limit the areas where additional worker respiratory protection is required, and reduce the scope of final facility decontamination.

Consistent with the guidance provided in DOE-HDBK-1169-2003, the ventilation design is based on dividing the Process Building into three ventilation zones to cascade air flow from normally occupied, non-contaminated areas to areas that have the highest potential for contamination. The ventilation zones were established by considering the potential for airborne or removable surface contamination, based on guidance presented in Table 2.5 of DOE-HDBK-1169-2003. The derived airborne concentrations and removable surface contamination values listed in Appendices A and D of 10 CFR 835 were considered in assessing the magnitude of potential airborne/removable surface contamination and the appropriate ventilation zone requirements.

The PBVS is a once-through cascade system. Supply air will be delivered to Zone 2, Zone 3, and non-zoned areas by the AHU supply fans. The negative pressure created in Zone 2 by the exhaust fans will draw air from Zone 3 to the Zone 2 areas. From the Zone 2 areas, air will be drawn into Zone 1 areas (Process Cells, CSSX Tank Cells, and Analytical Laboratory Hot Cell and gloveboxes) through inlet HEPA filters. Ventilation zoning will be maintained by: the routing of supply, transfer, and exhaust ducts; controlling fan operation; and regulating control dampers.
Exhaust air from the potentially contaminated Zone 1 areas is treated by two stages of HEPA filters, prior to being exhausted to the SWPF Exhaust Stack. Radioactive emissions from the Exhaust Stack will be monitored by an in-line radiation monitoring system.

The PBVS is also designed to maintain building temperatures for worker comfort, remove process or equipment heat loads, and prevent process upsets due to excessive temperature or freezing. The outside air is filtered for dust, followed by heating/cooling coils for temperature and humidity conditioning.

14.3.1 FSA and CPA Supply Air

Supply air to the FSA and CPA will use 100% outside air. The supply air will be delivered to Zone 3 areas, the Electrical and Mechanical Rooms, Operating Deck, and Analytical Laboratory by two of three AHUs. Each AHU is rated to handle 50% of total design air flow. Two AHUs will run continuously during normal operation. One AHU will be isolated for maintenance or maintained in standby, in case of failure of one of the operating AHUs.

Outside air louvers with bird screens allow air intake to the AHUs. Each AHU will include a roughing pre-filter, an 85%-efficiency particulate filter, heat recovery coil, chilled water cooling coil, and centrifugal air supply fan. Dampers will be provided at the discharge duct of each AHU for full isolation of the individual fan. An automatic flow control damper will also be located at the AHU discharge duct to maintain a constant supply air flow rate.

Two air-cooled chillers provide chilled water to the AHU cooling coils. A temperature element at the Zone 1 cell area exhaust duct will modulate chilled water flow to the AHU cooling coil to keep the Zone 1 cell exhaust below the maximum design temperature of 95°F. Heat recovery water pumps will be provided to circulate hot water between heat recovery coils located in the AHUs and prior to the PBVS exhaust fans to heat the cold outside air by utilizing hot exhaust air. The heat recovery water flow will be controlled to heat the AHU air inlet when the outdoor air temperature is below 60°F and cool incoming air when it is above 80°F. The supply air is branched into seven temperature zones, as listed below:

- Mechanical and Electrical Room;
- Operating Deck;
- Corridor, Toilet/Locker Rooms, Administrative Offices, HP Rooms, and Controlled Entry Area;
- Truck Bay/Dock;
- Storage Areas and Maintenance Shops;
• Exhaust Fan Room and Clean HEPA Filter Storage/Staging areas; and
• Analytical Laboratory.

Electric heating coils are located in supply branch ducts to individually control the temperature to each of the above supply air zones. Zone temperature elements control the heating coil for each zone.

14.3.2 Zone 3 Air Supply to Zone 2

AHUs will deliver supply air to Zone 3 areas, the Operating Deck (Zone 2), the Analytical Laboratory (Zone 2), and the Electrical and Mechanical Rooms (non-zoned) by sheet metal ducts. The Zone 3 air will then be transferred to Zone 2 areas via transfer air ducts between Zone 2 and Zone 3. Manual balancing dampers are provided to regulate this flow.

14.3.3 Zone 2 Air Supply to Zone 1

Air will be transferred from Zone 2 to Zone 1 areas via transfer air ducts to the Cell Inlet Air HEPA Filter Rooms #1 and #2, or individual inlet HEPA filters. Manual balancing dampers are provided to regulate this flow. The single-stage HEPA filters are provided to prevent the backflow of contaminants during a reverse air flow from Zone 1 into Zone 2. The ASDT and WWHT/SSRT Cell supply and exhaust flows and controls are designed to maintain a 125-ft-per-minute capture velocity across the opening when a filter access plug is removed for tubsheet assembly replacement.

14.3.4 Zone 1 Air Exhaust

Air is drawn out of the Zone 1 Process Cells, East/West CSSX Tank Cells, and Analytical Laboratory Hot Cell via exhaust ducts. The cell ventilation exhaust ducts are located above the cell floor at an elevation that precludes the intake being submersed, should a leak or inadvertent transfer occur. The air supply duct is generally located near the top of the cell on the opposite side of the exhaust duct. This design arrangement promotes cell sweeping and settling of airborne particulates toward the exhaust, thereby preventing resuspension of particulates into the Process Cell due to air currents.

An automatic control damper is located in each Process Cell inlet duct to control the cell pressure at -3.0 inches water gauge, with respect to atmosphere. This ensures that the cells are maintained at -2.7 inches water gauge, with respect to Zone 2. The automatic control dampers are located for accessibility.

The exhaust from each of the six Process Cells, the East CSSX Tank Cell, and West CSSX Tank Cell is provided with sample ports and the exhaust header is continuously monitored for gross beta radiation. If high radiation is detected in a cell exhaust header, the individual cell exhaust may be sampled to determine which cell is causing the high radiation. This information can then
be used to isolate that cell with the inlet duct damper. The cell inlet damper will also automatically close, if the cell high-high temperature alarm is activated.

14.3.5 Exhaust HEPA Filters

The PBVS is designed with four 33%-capacity HEPA filtration units. Three filter units and one exhaust fan are normally in operation, and one filter unit and exhaust fan are on standby. The radiation level of the stack exhaust air is monitored to provide an indication of filter failure. Should an alarm condition occur, Operators will isolate the leaking unit and the standby filter unit isolation valves will be opened to put the standby filter unit in service.

Each filter housing will be equipped with two stages of HEPA filters in series. The HEPA filters will be testable per DOE-STD-3020-05, Specification for HEPA Filters used by DOE Contractors\textsuperscript{155}. The filter media will have an efficiency of 99.97\% at 0.3-micron particle size, based on recommendations contained in DOE-HDBK-1169-2003\textsuperscript{150}. A fire suppression system will be installed. The filter housings will be stainless steel. Filter housings are designed with bag-in/bag-out features for filter replacement. Each filter stage is made up of 12 individual filters (each filter is 24 inches x 24 inches) to minimize the size of the individual filters to allow filter change-outs without a large and complicated rigging system.

14.3.6 Filter Testing

Filter testing shall be in accordance with ANSI/ASME N510-1989 (R1995), Testing of Nuclear Air-Treatment Systems\textsuperscript{156}.

HEPA filter inserts will be production-tested at the manufacturer for efficiency and pressure drop and will have individual serial numbers and test certificates/labels. HEPA filters that meet the criteria of DOE-STD-3020-05\textsuperscript{155} will be independently tested at the Filter Test Facility.

Filter efficiency testing by means of a challenge aerosol will be performed for each filter bank when the filter elements are installed. This testing will verify that the filter elements are seated properly and have not been damaged after leaving the manufacturer. Additional filter testing will be performed periodically as part of the SWPF preventive maintenance program to verify that each filter system is functioning correctly.

The dP is also measured across each filter stage. Alarms are annunciated in the CR if out-of-specification readings are detected. The dP readings are primarily used to determine when filters need to be changed, and also provide indication of HEPA filter failure.

The ductwork, dampers, filters, aerosol sample and injection points, and flow measurement test ports will be arranged.designed to enable this to be efficiently and reliably achieved, in accordance with applicable ASME standards.
14.3.7 Process Building Exhaust Fans

Two 100% -capacity exhaust fans (one operating and one standby) are provided for the PBVS exhaust. The exhaust fans will be driven by a VFD-controlled motor. The centrifugal fans will be specified with heavy-gauge steel casing. Automatic dampers at the outlet side of each exhaust fan will be provided. Manual dampers at the inlet of each fan will be provided for isolation purposes. The exhaust fan power can be supplied by the diesel generator.

The PBVS design includes a heat recovery system to recover waste heat/cooling from the exhaust. The closed-loop system circulates water between coils located in the exhaust duct on the fan suction side and in the AHUs. The system will be operated in both summer and winter months, when there is a sufficient differential temperature between the exhaust air and the ambient air to make operation economical.

14.4 Exhaust Stack

The PBVS exhaust header is ducted to the Exhaust Stack for discharge to the atmosphere. The PVVS and PMVS headers are treated by separate redundant filtration systems prior to their connections to the PBVS exhaust header. The AFF exhaust is ducted from the AFF exhaust fans to the base of the stack, where that flow combines with the PBVS exhaust.

The minimum design stack exit velocity is 3,000 ft per minute, based on the ASHRAE 1999 HVAC Applications Handbook and consistent with ANSI/American Industrial Hygiene Association (AIHA) Z9.5, Laboratory Ventilation. The final design and calculations will be performed by the stack vendor and submitted to the EPC for review and approval. Structural support and stack exhaust gas velocity criteria will be identified in the Exhaust Stack specification.


Although not specifically required for PIC-3 facilities, air samples will be continuously drawn from the Exhaust Stack and monitored for gross alpha and beta activity. The monitoring instruments and air sample pumps will be installed in an Instrument Enclosure that is located at ground level adjacent to the Exhaust Stack. The enclosure is designed to allow all-weather personnel access to the monitoring equipment. The CAM data provide an indication of filter failure. Should the high level alarm be activated, Operators will isolate the failed filter unit and place the stand-by unit into operation. UPS power panels supply power to the CAM System. Additional monitoring for the stack exhaust is not proposed.
14.5 Chilled Water System

Two air-cooled chillers (CHU-001A/B) with 50%-capacity each will be provided to cool the chilled glycol and water mixture used in the AHU coils to cool the inlet air. The PBVS chilled water is a centralized system to meet the cooling needs for the entire Process Building, including the AHUs located in the NFSA, CCA, and AFF. The supply air system is subdivided into three areas: CPA and FSA, AFF, and CCA. Each of the AHU supplies is specifically designed to serve its respective area. The air-cooled chillers will be helical screw or centrifugal type, suitable for ambient operation. The chillers will have the ability to unload down to 15% of operating capacity. The CHWS will include chilled water pumps (two at 50%-capacity each), strainers, control valves, expansion tank, and other ancillary equipment. PBVS chilled water is circulated through a closed-loop system by one of two supply pumps (P-001A/B). A Bladder Expansion Tank accommodates system temperature-induced expansion/contraction pressure fluctuations. System make-up water is provided by the PW System by a pressure control valve. The make-up water line is equipped with a flow switch that is designed to alarm, should excess make-up water flows be detected.

Two scroll-type air-cooled chillers with 100% capacity each will be provided for cooling the CR Inlet Air. The CR HVAC chiller design is similar to that for the PBVS supply air chillers.

14.6 Process Vessel Ventilation System

The PVVS is an active system that draws air through the vapor space of the process vessels and equipment that contain radioactive material. The PVVS exhaust fans are designed to maintain a negative pressure of -10 inches water gauge in the process vessels. This allows air from the Process Cell to be pulled into the vapor space from the vessel vents. The PVVS components can be powered from the diesel generator. Compressed Plant Air is supplied to various process vessels at low flow rates to purge the vessel head space. In the event of loss of Plant Air, a back-up supply of compressed air in cylinders or tanks is included in the design to continue providing SS purged air to the vessels for a minimum of four days. The air flow created by the PVVS or by the purge air system is designed to mitigate potential hydrogen gas accumulation in the vessels. Air purge is also provided to maintain directed air flow through the CSSX contactor labyrinth bearing seals. This purge air will be exhausted through the PVVS.

The PVVS includes redundant exhaust air treatment systems. Each treatment system includes a cooler, mist eliminator, heater, pre-filter, and two stages of HEPA filters. Each filtration subsystem is served by a dedicated exhaust fan for redundancy to allow maintenance and filter change-out without loss of ventilation exhaust. Failure of the operating filtration train or exhaust fan will result in automatic isolation of the failed subsystem and startup of the standby filtration train and/or exhaust fan.

Exhaust HEPA filters will be tested per DOE-STD-3020-05\textsuperscript{155}. The procedure used for testing the PBVS filter efficiency will also be used to test the filters for this system. Testing will verify that the filter elements are seated properly and have not been damaged after leaving the
manufacturer. In addition, filter testing will be conducted as part of the routine SWPF preventive maintenance program.

Each exhaust system will contain a centrifugal fan with heavy-gauge steel casing. Automatic dampers on the discharge side of each fan will be provided for switchover. Manual dampers on the suction and discharge side will also be provided for individual isolation of treatment train. The exhaust fans discharge into the PBVS exhaust header.

14.7 Pulse Mixer Ventilation System

The PMVS will be used to vent exhaust air from the APAs. This system will also contain redundant filtration trains and exhaust fans with a capability of automatic switchover to the standby filtration train or fan, when the operating train or fan fails to function correctly. Each filtration train includes a cooler, mist eliminator, heater, prefilter, two stages of HEPA filters, and an exhaust fan. The PMVS fans are designed to create a lower pressure within the APAs than in the vessel to draw fluid into the APA to shorten refill time and improve mixing, especially when the tank liquid level is low.

The APAs are designed to provide thorough mixing for solid-containing vessels that are located within the Process Cells. The mixing is required to maximize adsorption contact between the radiological constituents (i.e., actinides and Sr) and MST, prevent settlement of solids within the vessels, and promote continual disengagement of hydrogen gas from the waste matrix. Although failure of the PMVS and the APAs they serve would not result in unacceptable consequences from a nuclear safety perspective, the PMVS and APAs are integral to the Tank Agitation Program which will be a specific administrative control in the DSA. Tank mixing also prevents operational problems due to solids deposition in the vessels.

14.8 Control Room HVAC

The CR is provided with separate AHUs that operate independently of the PBVS supply and exhaust. The CR AHUs are intended to allow safe occupancy of the CR to permit operations personnel to remotely control and monitor the plant, if the PBVS AHUs or exhaust fans were to fail or if the Process Building inlet air were to become contaminated, resulting from an airborne release of hazardous materials from the SWPF or an adjacent facility. The CR AHU inlet from the outside environment can be remotely closed from the CR to place the CR HVAC in a recirculating mode. The CR HVAC system includes redundant AHUs and chilled water supplies.

The CR HVAC system consists of two 100%-capacity AHUs, each designed to filter, heat, and cool either a mixture of returned air and outside make-up air or 100% recirculated air. The CR HVAC has its own chillers and chilled water loop. The CR AHUs and chilled water supply can be powered by the diesel generator. Both systems are currently designated as GS, based on S-SAR-J-00001 because there is no Operator action required to maintain safe shutdown conditions under post-accident conditions. The SSP Room will have a dedicated heat pump.
14.9 Alpha Finishing Facility Ventilation System

The AFF is comprised of multiple zoned areas. The Process Area and the HEPA Filter Room are designated as Zone 2 areas. The personnel access/Airlock is designed as a Zone 3 area. The AHU Room is a non-zoned area. The AFF ventilation exhaust fans are located outside on a concrete pad.

The AFF is provided with a dedicated HVAC exhaust system. The AFF ventilation system is a once-through air system that supplies conditioned air to the Zone 3 areas of the AFF and exhausts the Zone 2 areas via HEPA filters to the Exhaust Stack. The AHU receives 100% outside air and provides conditioned air to the Zone 2 and 3 areas. The Zone 2 areas will be maintained at a negative pressure, with respect to the Zone 3 areas, by the AFF ventilation exhaust fans. These fans draw air from Zone 2 into a single 117%-capacity HEPA filter housing that consists of multiple isolatable sections. The filtered air is discharged to the Exhaust Stack. The filter has a pre-filter, followed by two stages of HEPA filters. Each filter row can be isolated for filter change-out.

Process Vessels located inside the AFF are ventilated into the building exhaust system through a demister and single-stage HEPA filter. The inclusion and operation of the demister is a vital component to ensure that calculated radioactive emissions are less than the 0.1 mRem/yr limitation that would require additional permitting and compliance provisions. The AFF ventilation design incorporates an active air purge system supplied from Plant Air to prevent buildup of hydrogen gas within the vessels.

14.10 Cold Chemicals Area Ventilation

The CCA is comprised of a chemicals preparation and storage area, Electrical Room, Mechanical Room, Operator station, restroom, and laboratory. The CCA is not within the Radiologically Controlled Area/Radioactive Materials Area Boundary.

The CCA is served by an independent, dedicated HVAC supply and exhaust system. Fresh air is provided by two 50%-capacity AHUs. Exhaust is by one of two redundant 100%-capacity roof-mounted fans. The AHUs can cool or heat the fresh air to maintain required temperatures in the work area. A supplemental heater provides additional heat for the Operator station and laboratory areas. The laboratory contains a fume hood that will run when the hood is in use.

The chemical tanks in the CCA are passively ventilated to their respective areas, except for the Nitric Acid Receipt Tank and Filter Cleaning Acid Tank. These tanks contain 20% by weight HNO₃ and are vented through the roof. The overflow for these tanks are equipped with a loop seal to prevent HNO₃ vapors entering into the building.
14.11 Analytical Laboratory Ventilation

Air flow in the Analytical Laboratory is designed to generally flow from the laboratory administration areas and corridors toward the Hot Laboratory and southern wall. Laboratory ventilation is designed to minimize potential for chemical or radiological contamination within the East and South Laboratory corridors. General Laboratory air flow is performed in accordance with ANSI/AIHA Z9.5\textsuperscript{158} and ASHRAE 62.1, *Ventilation for Acceptable Indoor Air Quality*\textsuperscript{161}. The ventilation design is based on supplying air to the laboratory offices and corridor. This air is transferred into the laboratory area (i.e., Organic, Inorganic, and Radiochemistry Laboratories), except for the toilet room, which is exhausted directly to the exhaust header. The air is then exhausted from the Organic, Inorganic, and Radiochemistry Laboratories primarily through the radio hoods, with a portion of the room air being exhausted through the gloveboxes. Additional conditioned supply air is provided directly to the Organic, Inorganic, Radiochemistry, and Hot Laboratories to balance exhaust air flows and for temperature/humidity control. Because the Hot Laboratory contains no gloveboxes or radio hoods, ducted exhaust connections are provided to maintain confinement.

The combined exhaust from the radio hoods is conveyed to the Laboratory Vent Room. The exhaust is treated by a scrubber to remove acid vapors and then HEPA-filtered. Scrubber blowdown is gravity-drained to the Lab Collection Tanks located in the AFF. A loop seal will be provided for the drain line, if required. The Laboratory exhaust system consists of the two parallel treatment trains, one operational and one on-line standby train. Selection of the operational treatment train is manually controlled. The treated exhaust is ducted to the main PBVS exhaust system just prior to the fans.

The design air flows for the radio hoods are based on using criteria from ANSI/AIHA Z9.5\textsuperscript{158} to determine sash opening face velocity requirements. The radio hood design includes sashes and windows that will maintain the appropriate airflow when open and closed. The sliding window allows adequate access to the entire radio hood, while minimizing exhaust air flow. The sliding window design also maintains the radio hood sash open area constant, which improves performance and control of the constant air flow design adopted for the PBVS. Low air flow monitors will be installed, as appropriate. Should servicing or replacement of analytical instruments or components require window removal for access into the radio hood, ventilation confinement will be maintained by automatic or manual re-balancing and administration of temporary RBAs.

A separate exhaust control and treatment system is provided for the gloveboxes, Hot Laboratory, and Hot Cell. The Hot Cell exhaust system is designed to maintain a lower pressure within the gloveboxes, and Hot Cell than the surrounding laboratory room pressurization. Glovebox inlets are equipped with an inlet HEPA filter to protect workers, should a flow reversal occur. Air flow into the gloveboxes is from room air. The air from each glovebox enters a common header and is transferred to the Hot Cell at the eastern wall. The combined glovebox design air flow is less than the required Hot Cell air flow. To provide additional ventilation air, the room air from the Hot Laboratory will also be transferred through the Hot Cell. The Hot Laboratory exhaust duct
will also be equipped with HEPA filters to guard against upsets resulting in potential flow reversals. Distribution of air flow to the Hot Cell from multiple inlet points allows individual HEPA filters to be isolated and replaced without needing to shut down the ventilation system. A bag-in/bag-out or push-through design will be used for the inlet filters to ensure that confinement is maintained during filter replacement.

The air is swept through the Hot Cell and exhausted from the western wall. Exhaust from the Hot Cell is treated by a scrubber to remove acid vapors and then HEPA-filtered. The scrubbers and HEPA filters are located in the Laboratory Hot Cell Exhaust Room. Scrubber blowdown is gravity-drained to the Lab Collection Tanks located in the AFF. A loop seal will be provided for the drain line, if required. The treated exhausts from the Hot Cell and radio hoods are combined and transferred into the main PBVS exhaust system just prior to the fans. The Hot Cell exhaust system consists of the two parallel treatment trains, one operational and one on-line standby train. Selection of the operational treatment train is manually controlled.

All Laboratory supply ductwork is designated GS/PC-1. The exhaust ductwork from the exit of the radio hoods to the actuated damper prior to the main PBVS exhaust header is designated GS/PC-1. Gloveboxes 8/9 and associated exhaust ductwork to the Hot Cells are designated SS/PC-1, due to the AFF sample loops that are contained within these gloveboxes. Ventilation components for the remaining gloveboxes are designated GS/PC-1. Hot Cell exhaust ventilation confinement through the Hot Cell exhaust HEPA filters is designated SS/PC-1. The remaining portion of the Hot Cell exhaust ductwork to the actuated damper prior to the main PBVS exhaust header is designated GS/PC-1. Laboratory sink drains, floor drains, transfer openings, and penetrations will be designed to limit air loss or unintentional chemical or radiological contaminant transfers.

The Laboratory design includes a supply and distribution system for helium gas from compressed cylinders that are located in the Laboratory Bottle Storage area. A storage cabinet is provided, sized to contain two Size K compressed cylinders. The cabinet is ventilated directly to the exhaust header to minimize potential for asphyxiation, in the event of a leak at the cylinder connection/regulators. All gas distribution systems will be welded, seamless pipe, or tubing.

Design of the Laboratory will be based on applicable NFPA Codes and Standards:

- NFPA 45, Standard on Fire Protection for Laboratories using Chemicals;\(^{162}\)
- NFPA 61, Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities;\(^ {163}\)
- NFPA 72, National Fire Alarm Code;\(^ {164}\)
- NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids;\(^ {165}\)
- NFPA 92A, Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences;\(^ {166}\)
- ANSI/NFPA 101\textsuperscript{58}, and

The Laboratory confinement and ventilation system is designed to ensure that toxic and flammable gases are removed from the Laboratory space and away from potential ignition sources. Flammability hazards associated with materials or vapors contained within the ventilated space will be considered to determine classification of electrical equipment and other potential ignition sources. Automatic fire dampers should not be located in laboratory hood exhaust ducts. The design and installation of duct systems for laboratory hoods will be in accordance with NFPA 91\textsuperscript{165}.

### 14.12 Compressor Building Ventilation

The Compressor Building is ventilated and heated; air supply cooling or conditioning is not provided. Ventilation air is drawn through wall-mounted louvers and discharged through roof-mounted exhaust fans. Ceiling-mounted electric unit heaters maintain minimum design temperatures in cold weather periods. Inlet air filtration for building ventilation is via an appropriately sized insect screen. The required louvers and dampers are sized to provide appropriate free area and pressure drop considerations.

### 14.13 Diesel Generator Ventilation

The D/G is an all-weather, self-contained enclosure that is normally not occupied. The ventilation and heating requirements will be vendor-specified and supplied with the package unit.

### 14.14 Administration Building HVAC

The Administration Building HVAC system will be supplied as part of the vendor-designed / built pre-engineered structure. The performance requirements for administration areas listed in Section 14.2 will be incorporated into specifications for the Administration Building.

### 14.15 HVAC System Control

All HVAC systems in the Process Building will be controlled and monitored through the DCS, with capability for startup, testing, maintenance, and emergency events. Remote control and monitoring shall be available from the CR and the SSP. The PBVS and AFF exhaust systems, PVVS, PMVS, and CR HVAC are required for normal operations and to provide DID capability for accident mitigation. The HVAC I&C system monitors temperatures, pressures, flow rates, and airborne radioactivity. Operations can be transferred to a redundant component or train if a failure is detected.

Back-up and UPS power will be provided for the Zones 1 and 2 air inlet and outlet sensors and dampers, all PBVS and AFF exhaust I&C components, and the stack monitor. The I&C components required for operation of the CR HVAC and PVVS, PMVS, AFF, and PBVS
exhaust systems are designed to fail safe, such that loss of power, or control signal failure shall result in the HVAC components failing to a position that allows the HVAC exhaust to perform its design function.

14.16 Duct Design

All ductwork will be designed to PC-1, except where two-over-one (II/I) analysis indicates that failure of ductwork would prevent a higher-category SSC from performing a required SS function following a design NPH event. To ensure continued functionality of these safety-related SSCs, ductwork will typically be designed to the same PC as the safety-related SSC. Duct supports will be designed to the same PC as the duct being supported.

The ductwork is sized and routed, based on the calculated flow rate, the available space for routing, the best practices guidelines in 2001 ASHRAE\textsuperscript{44}, and Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) \textit{Duct Design}\textsuperscript{168}. The duct dimensions are primarily sized by using an equal friction method at 0.08 to 0.1 inches water gauge pressure drop per 100 ft of duct. Requirements for fire protection, radiation shielding, and maintaining pressure zones will also be considered in the design for duct rerouting and penetrations.

Exhaust ductwork is primarily sized to maintain an average duct velocity equal to or greater than 2,500 ft per minute to minimize settling of particulates in the duct. The duct is assumed to have a smooth mill finish for stainless steel or G60 or G90 galvanized bright finish sheet metal, where applicable to the service. The intake air duct to the Cell Inlet Air HEPA filters will be a Level 4 welded stainless steel duct. The exhaust air duct from Inlet HEPA filters to the Exhaust Air Stack will be a Level 4 welded stainless steel duct. The transfer air duct in Zone 2 will be Level 3 galvanized steel. The supply and transfer air duct in Zone 3 will be Level 2 galvanized steel, in accordance with the DOE-HDBK-1169-2003, Table 5.1\textsuperscript{150}. Detail duct design (isometrics, duct fabrication sections, and supports) will be performed ahead of the Construction phase of the Project and shall be submitted by the subcontractor to the EPC Engineering Group for review and acceptance.

The following types of dampers are included in the design of the ventilation system.

- Volume control dampers will be used to control air flow rates. These dampers may be actively controlled or manually set during initial test and balance.

- Automatic and manual isolation dampers will be used to prevent flow through portions of the ventilation system. The isolation dampers will be placed before and/or after equipment for maintenance or to isolate a redundant train. The dampers will be bubble-tight or low-leakage, depending upon application.

- Fire dampers are included in the design where ducts penetrate fire-rated walls, floors, or partitions as required by Section 715 of IBC-2003\textsuperscript{59}, except in the exhaust system as required by Chapter 10 of DOE-HDBK-1169-2003\textsuperscript{150}. The dampers will have an equivalent fire-resistance rating to preserve the integrity of the fire barrier, per IBC-2003, Section 715. The dampers will be designed to automatically close in the event of a fire to prevent hot
gasses/sparks from passing from one fire zone to another. Duct penetrations through fire barriers that do not have fire dampers will be constructed per IBC-2003, Section 711, and DOE-HDBK-1169-2003, Chapter 10.

- Mechanical backflow dampers will be included in the design to preclude flow reversals that would result in dispersion of undesirable vapors, dusts, or impurities through manifoded duct systems. An actuated isolation damper may be used instead of a mechanical damper when full isolation is required.

All general purpose sheet metal dampers will be Air Movement and Control Association-labeled and rated for leakage and pressure drop characteristics. Material Levels and Storage levels shall be assigned to materials by the EPC’s Engineering and Procurement Groups.

All louvers, dampers, grilles, and registers will be specified for the appropriate leakage, water carryover, pressure drop, throw, velocity or diffusion and coordinated with the Architectural Group for appearance.

Test and balance (automated and static dampers) of air systems will be by subcontractor to the EPC. A test and balance report will be provided to Engineering for review and acceptance. Any non-conformance to the air flow diagrams will be reported to Engineering. Fail safe, controlled shutdown and upset condition settings will be coordinated with the Engineering and Commissioning Groups.

15.0 FIRE PROTECTION DESIGN

The SWPF fire protection systems and alarm and detection system consist of a combination of automatic sprinkler systems and additional suppression systems in HEPA filters and gloveboxes, wet standpipes, dry pipe, pre-action systems, deluge systems, and alarm systems. The alarm systems consist of automatic smoke detection, suppression systems initiation, manual pull stations, and alarm notification throughout the building.

15.1 Design Codes and Standards

DOE O 420.1B requires a Fire Hazards Analysis (FHA) to be performed and integrated into the Accident Analysis. This will provide the basis for the actual selection of controls and applicable requirements. The fire protection and detection system design for the SWPF was developed by following code requirements and using a combination of DOE and SRS experience, DOE-STD-1066-99, Fire Protection Design Criteria, the NFPA codes, and sound engineering judgment to anticipate the results of the FHA.

15.1.1 Underground Supply

The underground fire water supply for the SWPF is designed in accordance with NFPA 24. There will be two supplies for the facility, one at the west end and one at the east end. These supplies will be part of a new supply loop that also provides fire hydrant coverage for the exterior of the facility. The existing underground supply for S-Area provides adequate water
supply for existing and anticipated future demands. The estimated water supply demand for SWPF varies for each sprinkler system. The fire water supply line and the SWPF supply loop will meet the requirements of V-ESR-J-00017.

15.1.2 Standpipe Hose Systems

The Process Building interior standpipe hose system is designed in accordance with NFPA 14, *Standard for the Installation of Standpipe, Private Hydrants, and Hose Systems*. The current design of the standpipe hose system will also serve 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. Activation of the alarm system will be by pressure drop switches that are part of the riser check valves located at the west and east ends of the facility.

15.1.3 Automatic Suppression Systems

Automatic suppression system types consist of wet-pipe systems, pre-action systems, deluge systems, and a dry-pipe system. Automatic sprinkler suppression systems will protect the SWPF Process Building, Administration Building, and Compressor Building. These systems shall be designed in accordance with NFPA 13, Ordinary Hazard, Group 2, *Standard for Installation of Sprinkler Systems*. Activation will be by means of heat-sensitive sprinkler heads or heat detection, and flow switches will report system activation to the Fire Alarm Control Panel (FACP). Specific areas will not be provided with automatic suppression, as is documented in F-ESR-J-00002, *SWPF Fire Protection Engineering Equivalency Request Process Building Omission of Sprinklers in Process Vessel Cell Area* and F-ESR-J-00005, *SWPF Fire Protection Engineering Equivalency Request Omission of Sprinklers in Waste Transfer Enclosure; West Utility Chase; HVAC Shielding Chase; South Utility Chase, Contactor Support Floor Chase and East CSSX Tank Cell*. Suppression systems for the SWPF Process Building will be supplied from the interior standpipe distribution system. The Administration Building and Compressor Building will be supplied directly from the underground yard loop. System readiness is monitored by tamper switches on flow control (isolation) valves.

15.1.4 Final Exhaust HEPA Filter Suppression Systems

The final exhaust HEPA filters of the PBVS and AFF systems will be provided with a water-based suppression system. These systems shall be designed in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*. The systems will contain rate compensated heat detectors to send an alarm signal to the main FACP. The water spray systems will be manually actuated.

15.1.5 Alarm and Detection Systems

The alarm and detection systems will satisfy the requirements of NFPA 101 and NFPA 72, Private Mode rules, and will supplement the automatic suppression systems for SWPF. In general, the alarm and detection systems will consist of a fire alarm panel that reports to the central alarm station. Manual pull stations will be provided at each exterior exit and at each level
for the stairwells. Alarm/strobe appliances will be located throughout the facility, in accordance with NFPA 72. These will be addressable devices under constant monitoring by the FACP.

The Electrical Equipment Room and CR will be provided with smoke detection. The smoke detection for the Electrical Equipment Room and CR is designed to allow early emergency personnel investigation and response prior to activation of the sprinkler system.

Fire Dampers will be provided in air supply ductwork that passes through established fire area boundaries. Actual locations are subject to final configuration of fire area boundaries. The design and installation will comply with the requirements of NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems\(^{175}\) and NFPA 101\(^{58}\). Active ventilation confinement systems that are required to maintain operations and that pass through fire barriers will not contain fire dampers, but will be either wrapped with a fire wrap or analyzed in accordance with DOE-STD-1066-99\(^{169}\).

The SRS Fire Department has clearly defined specifications and communications requirements for facility fire control panels and subsequent communications. The Fire Protection System shall be in full compliance with NFPA for hazardous and radioactive materials industrial facility requirements and associated Occupational Safety and Health Administration requirements supporting fire protection systems inside and outside a facility. The SWPF will comply with Site requirements for equipment type(s), procurement, installation, and testing of the fire control panel.

The FACP is required to have back-up power. The FACP will be equipped with a self-contained power supply capable of 24 hours standby and 5 minutes of alarm power supply. The Site Fire Department will use the Fire Alarm System during facility drills. Audible and visual alarm notification appliances will be located in accordance with NFPA 72\(^{164}\), Private Modes rules. All fire and emergency support systems shall provide notification from the SWPF facility to the Savannah River Site Operations Center (SRSOC).

Requirements for the physical connection and wiring of the system are described in Sections 16.0 and 17.0 of this document.

15.1.6 Passive Protection Features

The basic SWPF design provides compartmentalization and segregation of various portions of the facility. The HVAC system design provides pressure boundaries to control contamination. Heavy concrete walls and fire-rated dampers serve the dual purpose of providing contamination control and fire-rated compartmentalization of the facility. NFPA 101\(^{58}\) requirements are satisfied by the inclusion of one-hour fire-rated corridors in some areas. Stairwells and other egress paths are protected in accordance with NFPA 101. Fire areas will be established, using the fire barriers described above to limit monetary loss. Penetrations through fire barriers will be sealed with UL Listed assemblies to maintain the integrity of the boundary. These products will include fire dampers, fire-rated penetration seals, and other opening protection.
15.1.7 Other Features

Fire extinguishers will be provided throughout the SWPF. Selection and location is in accordance with the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*. Where appropriate, fire extinguisher cabinets are used.

16.0 ELECTRICAL POWER DESIGN

The SWPF electrical power system includes the supply transformers, SDG, building power distribution, lighting, grounding, and lightning protection subsystems.

16.1 Design Codes and Standards

The SWPF electrical power system shall be designed per NFPA, ANSI, Institute of Electrical and Electronics Engineers, Inc. (IEEE), Illuminating Engineering Society of North America (IESNA), National Electrical Manufacturers Association (NEMA), other national consensus codes and standards, applicable SRS Engineering Standards as identified in P-DB-J-00002, and E-ESR-J-00001, *SWPF Electrical Acceptance Criteria*.

16.1.1 Power Sources

Electrical power for the SWPF is supplied from the H-Area 13.8-kV distribution system that is, in turn, supplied from redundant 115-kV/13.8-kV transformers located in 251-H. The transformers are tied to the 115-kV transmission loop grid system connecting to three switching stations and one generating station, all operated and maintained by South Carolina Electric and Gas.

Two 13.8-kV power sources, from Building 251-H (Feeder 7A and 7B) will feed the SWPF. A pole-mounted sectionalizing switch is provided so the open loop can be closed in the event that one of the feeders is de-energized by a failure or other administrative action taken by the Site M&O Infrastructure and Support Department. Conduit risers and medium-voltage cables running in concrete-encased duct banks bring power from the pole-mounted isolation switches to 13.8-kV switchgear assemblies immediately adjacent to the SWPF Process Building transformer pads. Normal power is distributed to the SWPF transformers from these switchgear.

Power (revenue) metering will be accomplished by installing current and potential transformers in the 13.8-kV primary switchgear.

The 13.8-kV primary switchgear 13.8-kV/480V transformers, 480V switchgear, 480V panels, 480V transformers, utilization voltage panels and 480V MCCs will have, as a minimum, 20% spare capacity to allow for post-construction load growth. The switching and interrupting devices including metering, protection, relaying, and regulating equipment shall be designed in accordance with the IEEE recommended practice and applicable sections of DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use With DOE O 420.1, Facility Safety* to ensure that the electrical system is properly protected.
Electric power systems and equipment ratings shall comply with ANSI/NEMA Standards, which establish standard maximum and minimum utilization voltages for electrical equipment manufactured in the United States.

Electrical power for the SWPF shall be distributed through the switchgear and MCCs at 480Y/277 Volts Alternating Current (VAC), 3-phase, 4-wire. Distribution transformers and distribution panel boards shall be used to provide 480Y/277VAC and 208Y/120VAC for miscellaneous lighting, power, and controls.

The electrical distribution system, raceway system (i.e., cables, conduits, duct banks, and junction boxes) and the cable tray system shall be designed in accordance with NFPA 709.

16.1.2 Standby Power Requirements

Standby power shall be provided to support systems or equipment components whose operating continuity is necessary to support essential process functions. The safety analysis and process reviews have determined that there are no SS/SC requirements that need to be met by the electrical power system. Essential production requirements are the primary reason for the SDG. The SDG will be sized to provide 20% spare capacity to allow for any potential load growth. The SDG primary role is to facilitate recovery operations and restoration of production after a loss of SRS normal power. The standby power supply components will be designed in accordance with NFPA 110, Standard for Emergency and Standby Power Systems; IEEE; and NEMA requirements.

S-SAR-J-00001 has shown that there are no events requiring standby electrical power for any SS system to perform its required safety function.

The design criteria, design features, qualification considerations, testing, and inspection requirements for the SDG shall consider the guidance of WSRC-IM-95-58, SRS Engineering Practices Manual, Engineering Guide No. 16256-G, Diesel Generator Systems. Normal power shall be supplied by redundant electrical distribution systems from the SRS 13.8-kV distributed system. Standby power is sourced from one SDG feeding through the ATSs to the MCCs.

Uninterruptible back-up power shall be provided for equipment that operates continuously and that must be energized in order to maintain operational functions. The UPS provides power to these loads while the SDG comes on-line and picks up the load. The UPS is energized from the SDG, if power from the SRS grid is interrupted.

16.1.3 Basic Electrical Materials and Installation Methods

General electrical material and equipment shall comply with NFPA codes and should be UL-listed, or listed by a nationally recognized testing laboratory recognized under 29 CFR 1910.7, Definition and requirements for a nationally recognized testing laboratory. Demand and diversity factors shall comply with NFPA requirements and IEEE recommended practices. Electrical systems have been designed such that an overall power factor \( \geq 85\% \) can be achieved.
Electrical equipment shall be anchored and laterally braced in accordance with the appropriate structural design requirements for the Performance Class of the equipment.

Conductors for interior electrical systems shall be copper. Conductors for power and branch circuits shall be at least No. 12 American Wire Gauge (unless noted otherwise on the electrical drawings). Conductors for Public Address systems shall be shielded cable. Conductor insulation shall be rated at 600V for 480V systems and 15-kV for 13.8-kV systems, in accordance with NFPA requirements.

Non-fiber optic signal cables shall not be run in close proximity to power cables or other cables that could induce currents, or couple voltages into the signal cables. Any conduit/cable tray penetrating fire-rated assemblies or architectural features shall be noncombustible, and the completed installation shall be sealed to maintain the original fire rating. Electrical raceways shall be installed per NFPA requirements.

16.1.4 Exterior Electrical Utility Service

Utility line locations shall be established in accordance with the appropriate clearance requirements and shall be routed within established rights-of-way. Minimum vertical and horizontal clearances for overhead lines shall be maintained as defined by Standard 16050 \((SRS Electrical Design Criteria)\) of WSRC-TM-95-1, SRS Engineering Standards Manual\(^{182}\) and ANSI/IEEE Standard C2-1990, \textit{National Electrical Safety Code} \(^{183}\). Buried cable shall be installed in duct banks, per NFPA requirements, and in accordance with the civil design criteria.

Electric metering (measuring kilowatt \([kW]\)-hours and demand) shall be furnished at each 13.8-kV main incoming metal-enclosed switch. Integrated power metering, measuring power, demand (\(kW\)), power factor, harmonics, phase, and line voltage shall be furnished for all switchgear and MCCs for load management purposes.

16.1.5 Grounding

Grounding systems shall comply with NFPA requirements and IEEE recommended practices. A separate ground (fault current return) conductor shall be provided in every electrical raceway. Metallic raceway systems shall not be used as a primary ground path. Outdoor transformer station grounding systems and grounding connections shall comply with IEEE recommended practice and the WSRC-IM-95-58, \textit{Engineering Guides Index}\(^{184}\).

Design and installation of grounding networks for sensitive electronic processing equipment shall comply with IEEE, NFPA, and ANSI requirements. These requirements and recommended practices will be met with a coordinated hierarchy of grounding tiers, with the final and bottom-level tier being the grounding counterpoise that encircles the Process Building and adjacent SWPF buildings.
16.1.6 Lighting

Exterior lighting systems shall comply with the IESNA *Lighting Handbook*<sup>185</sup>. Photocell control should be used to control lighting, as needed. Lighting installed at security posts shall be capable of providing a minimum illumination of 2 footcandles at ground level for at least a 30-ft-diameter circle around the security inspector post and 0.2 footcandles for 150 ft in all directions.

Interior lighting systems shall comply with the IESNA *Lighting Handbook*<sup>185</sup>. Exit lighting systems shall comply with NFPA requirements. Maximum use should be made of energy-efficient fluorescent fixtures and high-intensity discharge (HID) lamps, in accordance with the Energy Policy Act of 2005, Public Law 109-58<sup>186</sup>.

The use of common neutrals shall not be used in 277V or 120V single-phase branch circuit wiring. 3-phase, 4-wire circuits shall feature 3-pole circuit breakers, so that all three phases and circuits are interrupted when the circuit breakers are actuated. Single-phase 480V and 208V circuits shall feature 2-pole circuit breakers, so that all current-carrying conductors are interrupted when the circuit breakers are actuated.

Lighting fixtures equipped with internal back-up batteries will be strategically located to meet ANSI/NFPA 101<sup>58</sup> requirements. HID lamp illuminated areas will feature battery pack emergency lights. Due to delayed restrike characteristics HID lights will have an alternate means to provide continued illumination (e.g., auxiliary quartz lamp) after power is restored.

16.2 Electrical Power System Design

The SWPF electrical power system is designed to provide power from separate 13.8-kV feeders to two 13.8-kV switchgear within SWPF. 13.8-kV Switchgear SW-101 feeds 13.8-kV/480VAC transformers XFMR-101, -103, and -107 (part of Unitized Substation STA-201). 13.8-kV Switchgear SW-102 feeds 13.8-kV/480VAC transformers XFMR-102, -104, -108, and -106 (part of STA-201). Transformers XFMR-101, -102, -103, and -104 each feed a 480VAC switchgear located in the FSA Electrical Room and each of these 480VAC switchgear provides power to the MCCs located in the same room. Transformer XFMR-108 provides power to the SWPF Administration Building.

An electrical room featuring MCCs and distribution panelboards is provided in the AFF Electrical Room, which is fed from an outdoor unitized double-ended substation (STA-201) located south of the AFF. STA-201 includes XFMR-106 and -107.

The electrical power supplies for the redundant plant systems and subsystems are split between parallel MCCs and switchgear assemblies. All plant systems and subsystems, including the CSSX contactor lines, could continue to operate if either of the 13.8-kV feeders or 13.8-kV switchgear were to lose power.

Restoring plant operations by closing tie switches or circuit breakers will not provide a “bumpless transfer.” Operation of the plant in a configuration when all of the ties, switches, and
circuit breakers are “closed” is not a normal mode of operation for SWPF. In order to align the power system to the abnormal closed-tie configuration the Kirk-key interlocked switches and circuit breakers must be actuated. Whether in the normal or abnormal modes, the DCS provides control over the processes, and facilitates the coordinated restart actions for all process equipment.

The two 13.8-kV switchgear assemblies can also be cross-connected by coordinated mechanically-interlocked fusible switches to provide full power to all 13.8-kV/480VAC transformers and all downstream 480VAC switchgear. If either of the 13.8-kV switchgear assemblies loses power, the downstream 480VAC switchgear assemblies can also be cross-connected by cross-tie breakers (also coordinated and interlocked) between 480VAC Switchgear SWGR-201 and -202, between 480VAC Switchgear SWGR-203, and -204 and between the two 480V busses within the unitized double-ended substation STA-201.

MCC-201, -202, -209, and -210 are fed from 480VAC double-ended unitized substation STA-201. MCC-205, CHU-001A, and CHU-005A are fed from 480VAC Switchgear SWGR-201. MCC-206, MCC-207 (normal), CHU-001B, CHU-005B, and CMP-501C are fed from 480VAC Switchgear SWGR-202. These switchgear and MCCs provide electrical power to equipment considered to be non-essential. The loads supplied by these MCCs include HVAC AHUs, chillers, transfer pumps, agitators, cranes, normal lighting transformers, and normal utilization voltage transformers (208Y/120V).

The essential MCCs are MCC-203, and -204. MCC-203 is fed from 480VAC Switchgear SWGR-203, and MCC-204 is fed from 480VAC Switchgear SWGR-204. MCC-203 and -204 are fed by the SDG via ATSs, if normal power is interrupted. If normal power is lost, the SDG will start and the ATSs that serve the essential MCCs will switch the power supply for MCC-203 and -204 to the SDG switchgear (SWGR-205). A designated spare circuit breaker will be provided within the SDG switchgear (SWGR-205) to facilitate connection of a portable SDG or load bank. MCC-203 provides the normal supply and MCC-204 provides bypass supply to UPS USX-301.

Additional loads on SWGR-203 include Plant Air compressor CMP-501A and MCC-207 (alternate).

Additional load on SWGR-204 includes Plant Air compressor CMP-501B.

MCC-207 in the Compressor Building is fed from ATS-207, which is fed from SWGR-202 and SWGR-203. MCC-207 provides 480V AC power to the Compressor Building auxiliaries, including lighting and receptacle power, compressor lube oil heaters, oil and water circulation pumps, and compressor cooling units. Dual supply capability is provided to MCC-207 via the ATS-207’s ability to select power from either of two sources.

Essential load in the southern half of the Process Building including the CCA, AFF, and CSSX Area are fed from essential panelboards located in the AFF Electrical Room and derive their power from MCC-203 and -204.
The essential loads fed from the standby bus MCCs include all plant equipment that performs essential process functions. S-SAR-J-00001 does not credit any SC or SS equipment for prevention or mitigation of events that require electrical power to perform their safety functions. Based on this, none of the electrical distribution components or the SDG are considered SS. The following list incorporates the changes of DCR-0025, DCR-0122, Interoffice Correspondence 11-700-00003 (Subject: Revised Loading of the Diesel Generator and Standby Power System), and as revised by 00-700-02458, Diesel Generator Sizing and Plant Equipment Restarting Subsequent to Standby Power Availability. The essential loads provided with standby electrical power include the following:

- CR AHUs (AHU-004, -005);
- CR Heater coils (AHU-004, -005);
- CR Chillers (CHU-003A/B);
- CR Chilled Water Circulation Pumps (P-003A/B);
- PVVS Fans (FAN-401A/B);
- PVVS Heaters (HTR-401A/B);
- MST Storage Tank Agitator (AGT-311);
- MST Transfer Pump (P-311);
- Strip Effluent Transfer Pumps (P-205A/B);
- Washing Filter Feed/Sludge Solids Transfer Pump (P-104-1);
- PW Utility Pump (P-301-1);
- Flush Pump (P-301-2);
- ASDT Transfer Pumps (P-601A/B);
- Process Building Exhaust Fan (FAN-001/002);
- PMVS Exhaust Fan (FAN-402A/B);
- HVAC Scrubbers (SCB-001, -003, -002, -004);
- Salt Solution Feed Pumps (P-109-A/B);
- 20/7.5/1 Ton Operating Deck Bridge Crane (BC-101);
- PMVS Vent Heater (HTR-402A/B); and
- UPS USX-301, which feeds essential electronically powered control systems, including the Instrument Control Panels.
16.2.1 Electrical Power Source

Electrical power for the SWPF is supplied from Feeder 7A and 7B to the existing 13.8-kV substation 251-H which is part of the SRS power system. The SRS grid is a system of substations and 115-kV transmission lines coordinated to form a reliable electrical power system for various SRS facilities.

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

- Medium (13.8-kV) voltage power is provided to the site by two separate transmission lines;
- The 115-kV substations and transmission lines are connected to form an SRS Site-wide loop system;
- Switching facilities at 115-kV and 13.8-kV substations permit sectionalizing of transmission lines;
- With equipment and circuits in service, the grid can sustain the loss of a substation transformer, a 115-kV line, or a 115-kV line section without causing a serious overload or interruption of essential service; and
- The 115-kV grid is protected from lightning by static and ground wires and lightning arresters.

16.2.2 Normal Power

The Site Normal Power System provides the area with a continuous source of electric power to the SWPF. Two independent 13.8-kV power feeders provide power to the SWPF via two 13.8-kV switchgears (13.8-kV Switchgear SW-101 and 13.8-kV Switchgear SW-102). These switchgear assemblies supply seven 13.8-kV/480Y/277VAC transformers. 13.8-kV Switchgear SW-101 feeds 13.8-kV/480VAC transformers XFMR-101, -103, and -107 (part of Unitized Substation STA-201). 13.8-kV Switchgear SW-102 feeds 13.8-kV/480VAC transformers, XFMR-102, -104, -108, and -106 (part of STA-201). Transformers XFMR-101, -102, -103, and -104 each feed a 480VAC switchgear located in the FSA Electrical Room.

Circuits shall be arranged so that faults, failures, or maintenance on less critical circuits will not jeopardize essential process loads. Protective devices shall be used and coordinated for sequential operation from the load to the source.

Surge protection shall be included to limit the potential difference across the terminals of the protected device to below the Basic Insulation Level of the device. Surge protection for overhead lines and grounding for surge arresters shall be designed to meet the requirements defined in WSRC-IM-95-58184.
16.2.3 Standby Power Supply

A loss of normal power will result in under-voltage detection at ATS-203 or -204, either of which will send a start signal to the SDG. The ATSS will transfer to the standby power source after the SDG starts and the proper voltage and frequency has been supplied to the standby (generator-side) terminals of the ATSS. Power is then provided by the SDG to MCC-203 and -204, through the generator-side of the ATSS and SDG Switchgear SWGR-205. The SDG shall be capable of 1) automatically starting and reaching rated speed, and 2) accepting loads after a 10-second stabilization period.

The SDG will supply all loads powered by MCC-203 and -204. The SDG has an approximate rating of 1,000kW, 0.8 pf, 3-phase, 4-wire, 60-Hertz (Hz), 480V. The SDG is capable of maintaining a voltage of not less than 85% and a frequency of not less than 95% nominal throughout the duration of loading. The DCS will regulate which loads are energized via MCC-203 and -204 at any given moment. Each essential system will be provided with electrical power to supply any one of the redundant components or trains.

The SDG unit has a skid-base day tank of approximately 100 gallons. Refilling of the day tank is by redundant transfer pumps provided for the main fuel storage tank. The main fuel storage tank has a capacity of approximately 10,000 gallons, for approximately 4 days of continuous operation. The SDG will be housed in a vendor-supplied enclosure with all support systems and fuel oil supply self-contained, except for the main fuel storage tank. The SDG will meet Tier II emission standards (40 CFR 89.112, Oxides of Nitrogen, carbon monoxide, hydrocarbon, and particulate matter exhaust emission standards\(^{189}\) and 40 CFR 89.113, Smoke emission standard\(^{189}\), in order to comply with the requirements of 40 CFR 60, Subpart IIII, Standards of Performance for Stationary Compression Ignition Internal Combustion Engines\(^{190}\).

16.2.4 Uninterruptible Power Supply

Uninterrupted back-up power shall consist of a 3-phase, on-line, solid-state, double conversion UPS system. In this configuration, the input power is converted to DC, which is bussed to an inverter stage that converts the DC back into AC. The batteries are charged continuously from the intervening DC bus. Upon loss of normal power, USX-301 provides bumpless and distortion-free power to the 208Y/120VAC loads that are connected. USX-301 provides power to an internal output transformer/power conditioner to protect against transient voltage dips, flicker, electromagnetic interference, frequency drift, and other disturbances that can cause false operation of sensitive I&C circuits. Additional surge protection is also provided for the DCS equipment. Only essential and safety operations equipment, and I&C are connected to the UPS power bus. Excess capacity of 10% is provided for post-construction load growth.

The UPS System features Valve-Regulated Lead-Acid battery packs in vertical floor cabinets. The UPS cabinet features a DC rectifier/charger, power conversion equipment, a static transfer switch, and maintenance bypass switch panel. The UPS is provided with two (SDG-backed) input AC power sources (normal supply and bypass supply). The UPS battery is sized to carry the required connected loads for at least 30 minutes. The SDG can provide power to the UPS
Rectifier/Charger and maintenance bypass switch. The bypass supply to the UPS output isolation transformer is provided for performing any repair or maintenance service to the UPS module. Operation of the UPS bypass switch is administratively controlled.

The UPS will be specified, designed, manufactured, and installed according to the performance requirements of the NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems* for a Type O, Class 0.5, Category B, Level 2 system classification.

There are no engineering requirements to provide 125 Volts Direct Current (VDC) power to the electrical switchgear. This will allow the UPS battery to be dedicated to serving the UPS without parasitic loads tapped into the battery for other equipment loads.

### 16.2.5 Grounding and Lightning Protection Systems

The Grounding and Lightning Protection System design is an integral part of the facility-wide design approach to incorporate inherent safety features that emphasize a simple approach to system design and a passive approach to safety. The Grounding and Lightning Protection System will contribute to safe operation of the facility by providing safety to personnel and equipment from ground fault current, static electricity dissipation, and lightning strikes. This safety is achieved by designing the system to:

- Limit the soil gradients (during ground fault conditions) inside and outside the plant area to safe values;
- Achieve a low resistance value to earth for safe transfer of potential, or otherwise provide the necessary measures to electrically isolate the Grounding and Lightning Protection Systems from remote grounds;
- Provide adequate grounding for plant equipment; and
- Provide a single-point connection to earth for the computer/DCS.

The SWPF will not use the Dissipation Array System that is employed on the DWPF. The SWPF uses a conventional “Franklin-type” air terminal and down-conductor lightning protection system, in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*. This lightning protection system shall be installed on or provide coverage for the following structures:

- Process Building (including CPA, CCA, FSA, and AFF);
- Exhaust Stack;
- Compressor Building;
- SDG;
- Chiller Area;
• Outdoor Transformers, unitized substation; and
• Administration Building.

Safety Basis document S-SAR-J-00001\textsuperscript{11} credits the grounding and bonding of process components with providing spark prevention. Grounding details, verification, and testing of ground bonds for dark cell components meeting these requirements will be shown on the drawings.

16.2.6 Power Monitoring and Metering

Watt-hour demand power metering will be installed within the metal-enclosed 13.8-kV switch line-up at the incoming main switches on the line side of each of the two 13.8-kV busses. Secondary metering to tabulate the site power consumption will not be provided. Primary metering will not be on each of the transformers, due to the sufficiency of metering the 13.8-kV feeders.

Each of the 480V switchgear assemblies will feature integrated sub-metering at each of the incoming main circuit breakers and at each MCC feeder circuit breaker, which will provide data on:

• kW and kilovar Power Consumption and Demand,
• Power factor,
• Frequency,
• Line current and voltage,
• Voltage and Current Harmonic content, and
• Fault Analysis.

The Integrated Power Monitoring System will be configured to provide a trouble alarm to the DCS for operator monitoring.

16.2.7 Area Classification

The areas in which flammable hydrocarbon materials are present have been classified as recommended by SWPF-10-120, Review of SWPF Electrical Classification, (Letter, Breor to Smith, 00-700-14660)\textsuperscript{193} in accordance with NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gasses or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas\textsuperscript{194}, and NFPA 70\textsuperscript{99}. Cathodic Protection

The Cathodic Protection (CP) system is an impressed current system connected to the jacket pipe of the WTLs. These transfer lines are located at the west and east ends of the SWPF Process Building and AFF, respectively. The coated jacket piping is protected from aggressive corrosion by an anti-corrosion coating system directly applied to the outer surface of the pipe. This coating
system is supplemented by the CP system. The CP system is passive, with no active elements. The CP system also provides test stations to measure pipe-to-soil potentials between the anodes and the protected piping.

### 16.3 Electrical Operability Considerations

Major features of the electrical system that enhance its reliability are listed below. (Exceptions to some items may exist where analysis shows that omission would not degrade the system below acceptable levels.)

- S-SAR-J-00001\(^{11}\) has shown that no events require standby electrical power for any SS system to perform its required safety function.
- Standby power is provided to the CR HVAC systems, Process Building exhaust fans, MST process agitators, and transfer and feed pumps.
- Onsite power supplies, switchgears, and MCCs have sufficient redundancy and reliability to satisfy the system availability assumptions used in P-ESR-J-00003, *SWPF Operations Assessment and Tank Utilization Models*\(^{195}\).
- The SDG and standby electrical distribution equipment shall be fully testable.
- Electric power is supplied to the northern SWPF building loads through four 13.8-kV/480VAC transformers and associated switchgear (Switchgear SWGR-201, -202, -203, and -204). All four transformers and switchgears are normally energized, and each transformer and associated switchgear is rated to carry half the SWPF loads.
- Electric power is supplied to the southern SWPF building loads through two 13.8-kV/480VAC transformers, contained within unitized substation STA-201.
- Electrical power is supplied to the SWPF Administration Building power panel through a 13.8-kV/480VAC transformer. Power to this building is provided by a simple radial non-redundant feeder.
- All breakers, switchgear, MCC busses, and power panels shall be designed to permit periodic inspection and testing.
- Electrical apparatus is sized on the basis of the most severe load demand (continuous or intermittent) and adverse environmental conditions.
- Power transformers are sized for the largest combination of continuous loads plus an allowance for short-time or intermittent loads.

### 17.0 INSTRUMENTATION AND CONTROL DESIGN

The DCS is the primary control system for the process and most ancillary services. Some packaged control systems, such as chillers, are furnished with their own control systems that are integrated into the DCS for remote monitoring and supervisory control. The DCS is comprised of two separate systems, the Basic Process Control System (BPCS), which monitors and controls
the process, and the Safety Instrumented System (SIS), which performs all identified Safety Instrumented Functions (SIFs).

The BPCS is based on the use of bus technology, with preference given to Foundation Fieldbus (FF) for communications with transmitters and modulating final control elements. DeviceNet (or similar bus) is preferred for motor control and primarily discrete-type input/output (I/O). The different busses connect to controllers that are linked to Operator display and the BPCS server via redundant High-Speed Ethernet (HSE). Application servers also reside on the redundant HSE. They are used to interface with and integrate control and information from other packaged control systems.

Bus technology affords greater flexibility in modifications, troubleshooting, and maintenance, as well as providing a “small footprint” for I/O. The applications servers provide greater flexibility in the ability to integrate vendor-furnished controls into a common control system.

The PIN is the Site data collection and reporting system that retrieves pertinent data from various control systems for display and reports. The system uses Plant Information (PI) Historian software. The DCS Historian is compatible; however, there is no direct link to the Site PIN at this time.

The TCDS system is the network of telephone and data cables interconnecting the various facilities.

Field instruments will typically be FF technology versions, permitting flexible control, data logging, on-line calibrations, off-line testing, and other O&M functions.

Each FF segment connects to a communication module that, in turn, communicate to the BPCS Server via redundant Ethernet links. This provides hardware redundancy down to the FF level to ensure reliability of the controls and monitoring system.

Additional support systems separate from the DCS, but integral to the overall operation of the process, include the:

- CCTV System,
- Public Address System,
- Facility Access Control System,
- Fire Alarm System,
- Laboratory Information Management System (LIMS),
- Maintenance Management System,
- Plant Data Warehousing and Reporting System,
- Environmental Monitoring System,
• Radiation Monitoring and Industrial Health data management systems, and
• Operating Deck Crane Control System furnished as a package with the crane.

External to the SWPF is the TCDS linking the SWPF with DWPF, SPF, H-Area Tank Farm CR, SRSOC, and other SRS emergency and support facilities. These TCDS links are described in detail in V-ESR-J-00012\textsuperscript{24} and V-ESR-J-00013\textsuperscript{25}.

17.1 Instrumentation and Controls Design Philosophy

The SWPF I&C design is based on satisfying the following design objectives:

• Provide automatic safe shutdown capability;
• SIS shall conform to ANSI/International Society of Automation and Control (ISA) S84.00.01-2004, Application of Safety Instrumented Systems for the Process Industries\textsuperscript{196};
• Minimize or eliminate the impact of a single point failure;
• Enable remote control of routine ASP, CSSX, and AFP operations;
• Provide access to all monitored data in the CR;
• Monitor and trend equipment performance parameters for maintenance planning;
• Provide built-in testability and diagnostics capability; and
• Use systems compatible with existing BPCS and PI systems used by the Tank Farms, DWPF, and SPF.

The following I&C design features or capabilities are used to achieve these objectives.

• The SWPF I&C System will monitor selected process variables and systems, and provide the ability to automatically control process operations within the designed operating envelope.
• The SWPF I&C System will detect and alarm off-normal conditions and provide controls and information to allow proper Operator intervention. The System will also provide automatic initiation of control sequences to place the SWPF in a safe condition, where applicable.
• Systems classified as SS will be executed with a SIS. Linking of normal I&C systems and SIS will be limited to ensure that important-to-safety control functions are not impaired by failure of a normal control system component.
• Human factors engineering principles will be applied to all aspects of Operator interface design. A simple and consistent Operator interface will be implemented to facilitate Operator decision-making and inhibit erroneous Operator inputs.
• High levels of automation will be implemented to optimize process throughput and minimize staffing requirements.
- Extensive diagnostics will be included to reduce downtime and maintain process operations well within required operating control limits.
- Computerized O&M documentation will be provided to allow timely and convenient access to information.
- Plant operational data will be electronically recorded and archived for future use in trending, life-cycle maintenance, or incident investigation.

17.1.1 Interlock Philosophy

Plant actuators may be subject to two sets of trips and interlocks. In principle, these are distinguished as follows:

- Safety Interlocks executed by the SIS provides independent protection for environmental, personnel, and major plant protection purposes; and
- Process and control interlocks executed by the BPCS provides control systems interlock to ensure that normal plant operation will be kept within its design envelope and provide protection to major plant items.

17.1.2 Operator Interface Philosophy

CR consoles will consist of flat-screen terminals providing detailed plant mimics, sequence initiation, alarms handling, diagnostics, and trending information. In operational modes, the Operator will have control access and current status of all or designated parts of plant processes, direct support and indirect support system functions, facility and SWPF site monitoring functions, and emergency/event controls. The four Operator consoles (work stations) in the CR will each have the capability to monitor and control of any part or all of facility processes. The Shift Supervisors console will have the capability to access all facility upper level information and status with supervisory control and can be used as a back-up Operator work station to provide direct control for operations.

17.1.3 Alarm Philosophy

To ensure effective operator response, all alarms shall be categorized as the basis for alarm prioritization within the CR. Alarm categories shall include the following:

- Critical Alarms: Critical alarms indicate conditions exist that challenge the Authorization Basis, indicate entry into a Limiting Conditions for Operation, or are entry conditions for emergency events. SIS alarms also annunciate on the BPCS as a critical alarm. Critical Alarms require operator action to prevent demands on the important-to-safety SSCs.
• Warning Alarms: Warning alarms will prompt the operator to take action to mitigate the situation to prevent equipment damage. Warning Alarms indicate that operating limits have been exceeded and operator action is required. Warning Alarms are warning that operating limits are being approached or that an operation has halted due to an abnormal condition. Operator shall determine if action is required.

• Advisory Alarms: Serve to notify the operator when operational parameters are outside of the normal range or hardware/interlock abnormalities exist.

• Operator Prompt: Non-intrusive messages informing operator of normal device state changes, sequence phase changes, and operator prompts.

• Log Events: Record information in the Event Chronicle, logging normal DCS control functions during various evolutions.

17.1.4 Data Management Philosophy

Collection of certain categories of information is required to provide support of Facility operation and product data to the customer and regulatory bodies. Software systems will be used to support the following:

• Production planning and scheduling;
• Maintenance management, including material warehousing and stores;
• Laboratory information management;
• Waste tracking and inventory management (both product and secondary waste); and
• Data warehousing of process and production data in order to satisfy data recording, archiving, and reporting requirements intrinsic to the following:
  – Operations,
  – Management,
  – Customer (DOE),
  – Regulatory,
  – ESH,
  – QA
  – Engineering, and
  – Maintenance.

The data historian equipment should be specified to be commercial off-the-shelf wherever possible. Software security should be provided for the EDMSs, where applicable. Engineering drawings, procedures, etc., will be maintained in accordance with the EPC’s V-QP-J-00001 to prevent unauthorized change or loss.
17.2 Location of Control

The SWPF has one CR and an SSP located in a room separate from the CR. Crane control console for the CPA Operating Deck will be in the CR, as will the alarm display, CCTV display, and BPCS Operator stations.

A separate control station for the Cold Chemicals Systems is located within the CCA and is the primary point of control for the Cold Chemicals Systems. It is intended that all control other than Cold Chemicals be from the CR in the Process Building. Interfaces to all off-facility services are located in the CR. Control, monitoring, and communication functions planned for the CR include:

- Control and monitoring of startup, operation, shutdown, and batch operation for the process facility;
- Control and monitoring of ventilation startup, operation, and shutdown;
- Control and monitoring of mechanical handling process operations;
- Control and monitoring of services and utilities operations;
- Fire surveillance;
- Environmental surveillance;
- Emergency shutdown initiation and indication;
- Monitoring of independent protection interlocks;
- Normal and emergency telephone communications;
- Public Address and building evacuation communication;
- Computerized access to O&M documentation;
- CCTV;
- Exhaust Stack discharge monitoring;
- Radiological contamination monitoring;
- Building and facility access control;
- Control and monitoring of laboratory sample collection and transport systems;
- On-line/off-line remote maintenance data logging and instrument calibration; and
- Store and use space for hard copy of documentation required for operation and troubleshooting.
17.2.1 Safe Shutdown Panel

Should the CR become uninhabitable or inaccessible, the SSP Room is equipped with an operator console, telephone and radio communications, fire alarm annunciator, and other equipment sufficient to allow the Operators to either initiate a shutdown, if required, or maintain the process in a safe state while awaiting re-entry to the CR. The SSP is located in a dedicated room on the west side of the CPA, with entrance from outside the CPA only. Some of the functions provided are:

- Emergency shutdown initiation and indication;
- Monitoring of SIS;
- Monitoring of process facilities within the building;
- Monitoring of ventilation for the building;
- Environmental surveillance for the building;
- Public Address communications;
- Limited CCTV of the facility;
- Telephone communications, including SRS Selective Signal telephone;
- Computerized access to O&M documentation; and
- Essential monitoring of building radiological and temperature indications.

17.2.2 Local Monitoring and Control

The process does not require and the design does not provide local monitoring and control. Ethernet ports for connecting a control console are available at each ICP.

17.2.3 Degree of Automation

SWPF operations will maximize CR and remote automation of processes via the BPCS and FF-based remote processing of local repetitive operations. Packaged systems will have local processing with links to the BPCS and other facility data logging and archiving systems, as required.

Normal process operations are automated to the extent practical. Interlocks will take specific immediate control actions on alarms (as defined) to minimize process impact. Alarm displays are provided to provide additional information to facilitate Operator assessment and action.

Valve position indicators on automated valves provide positive valve position feedback, allowing valve position display and interlocking to ensure proper valve alignments for the intended operations.
17.2.4 Distributed Control System Configuration

The SWPF control is based on an Emerson Delta V DCS for BPCS and Triconex Tricon for SIS. Use of this DCS will ensure reliable process operation, personnel and facility safety, quality products, and cost-effective operations.

The BPCS provides real-time control and monitoring of the SWPF and its equipment. The BPCS design includes a server, RAID 5 disk array, redundant Ethernet interconnections, redundant workstations, and redundant controllers in each ICP. This provides a high degree of reliability to the field device.

The DCS configuration includes the following:

- Four Multi-screen Operator workstations; one station will be dedicated to each process (i.e., ASP, CSSX, and AFP) and the fourth station will be used for waste transfers and utility systems (a separate workstation in the CCA will be provided to manage cold chemicals unloading and preparation functions);
- BPCS server and software;
- Various bus technologies to interface with field devices and motor controls;
- Traditional I/O modules, where bus technology field devices are not available;
- Field devices, as required, for monitoring and controlling the processes;
- A robust communications network supporting the control system infrastructure; and
- Remote connections to facilitate maintenance restart and Measuring and Test Equipment functions.

17.2.5 Safety Instrumented Functions

The functional electronics of instruments, sensors, actuators, transmitters, valve controllers and positioners, radiation detectors and transmitters, turbidity, flow, pressure, vibration, speed, and temperature elements and transmitters, and various other instruments exposed to hazardous chemicals and radioactivity meet stringent operability, reliability, and functional lifetime criteria commensurate with their importance to safety. These devices will comply with ANSI/ISA S84.00.01-2004 Safety Integrity Level (SIL) requirements. All SIFs in SWPF have been designated in S-SAR-J-00001\(^\text{11}\). Safety functions are executed with an SIS conforming to the requirements of ANSI/ISA S84.00.01-2004\(^\text{196}\).

17.2.6 Control Modes

Process automation is used to minimize the number of stages requiring Operator control. The degree of automation will depend on the area of concern, process performed, and frequency of operation. Typically, process automation executes sequentially until an Operator decision is
required. Operations that have operator initiation or intervention typically include sampling, effluent management, decontamination, and batch transfers of fluids.

Mechanical handling operations will use sequence control and stepped permissive logic where possible, thereby minimizing the number of stages requiring Operator initiation.

Meeting operations requirements necessitates distinct control modes, which are discussed below (note that not all modes will necessarily be available at each control location).

### 17.2.6.1 Automatic Mode

Automatic Mode is an operational sequence or continuous action that, once initiated, will operate continuously or run to completion without additional Operator interaction. The degree of automation will depend on the particular area of the plant, process and technical risks, safety, human factors recommendations, and frequency of operation involved. Some examples of automatic control include the following:

- Operator-initiated startup and shutdown sequences of continuous processes;
- Operator-initiated sequence control of batch processes and mechanical handling;
- Pressure, flow, and temperature control loops;
- On-line diagnostics and calibrations; and
- Safety systems logic control of process and support equipment.

Following initiation, an automatic sequence of operations will continue until 1) completion, 2) abnormal condition shutdown, or 3) Operator intervention occurs.

### 17.2.6.2 Manual Mode

Manual Mode allows the Operator to directly affect a final control element, such as a valve external to the automatic sequence. In general, the sequence of control algorithm must be removed from the Automatic Mode and placed in the Manual Mode, which gives the Operator ability to directly manipulate final control element(s) individually. All operational and safety interlocks will be preserved. Manual Mode operations will only be possible with the proper authorization. The control system records all Manual Mode actions. A diagnostic display and printout of manual operations will be available. The system displays operational mode status on the Operator workstations.

### 17.2.7 All Stop Shutdown

Operators will use the normal control systems to initiate an all-stop command to quickly place processes in a safe state. All stop alarms will be Category I. All stop shutdown zones affecting only certain processes may be developed and implemented in Critical Decision-3 design. The
DCS can accommodate this structure if it is deemed necessary. The all stop command can be initiated from the SSP console when the CR is not habitable.

17.2.8 Diagnostic Alarm Annunciation

The SWPF BPCS will have hierarchical communication protocols to control the level of information presented and displayed. The software controls will include on-line real-time diagnostics, on-line calibrations, instrument and equipment historical trending, off-line simulation and software modeling/testing, predictive maintenance analysis and automatic scheduling, pre-processing analysis of equipment availability and reliability for the batch in queue, and failure analysis and impact upon in-process batch quality and processing time. Other key software will be available for lower-tier Reliability, Availability, Maintainability, and Inspectability functions.

17.2.9 Authorization Techniques

The DCS provides multi-tier access, password accounts and administrative authorization to allow customized levels of access the system.

17.2.10 Seismic Aspects

The hazard analysis does not identify a requirement for the normal control system to continue to operate during or after a seismic event. All I&C safety functions shall be handled through the SIS. SIS instruments identified as having to function post-seismic will be seismically qualified to PC-3. Valves identified as having an SS function to maintain process containment boundary will be seismically qualified, but not the actuators.

17.3 Reliability, Availability, and Maintainability

The SWPF architecture will allow each system to operate independently of all other systems, to the extent practical. A failure in one system should not adversely affect the operation of any other. Some degree of redundancy may be applied to the control network and system hardware to allow CR workstations and local Operator interfaces to control and monitor more than one system concurrently for a facility, should a control system component failure occur.

17.3.1 Reliability

Assurance that the SWPF will not fail to an unsafe state in any circumstance is the responsibility of the independent protection systems, which will be engineered on a case-by-case basis to support component specific requirements. This process will determine the required levels of integrity, reliability, and safety availability for each independent protection system.

By maintaining separation between the independent protection systems and the control systems, the safety impact of control system failures is mitigated. The reliability of the control systems is primarily based on business and operational drivers.
To improve overall plant performance, critical plant equipment may be installed with back-up. Control systems will be engineered to ensure that a single component failure will not adversely affect the operation of primary and any standby equipment.

The control system reliability target will be calculated on a per-function basis (process or mechanical handling). The determination of reliability will account for all components required for normal control of each function. Reliability will be expressed as the mean time between failures (MTBF) in hours.

A failure is defined as any event that halts and prevents an operation from continuing under normal control. A failure does not imply failure to an unsafe state, but does imply loss of the Operator’s ability to change state via the control system. A fail-over to a back-up condition will not be considered a failure at the system level, provided that operation is not prevented from continuing in a timely manner.

In an effort to reduce the impact of control system failure on each overall system performance, the target for the control system is an MTBF of 17,500 hours.

17.3.2 Availability

Availability is to be defined as MTBF/(MTBF + mean time to repair [MTTR]). Given the above requirements, the target availability of the normal control system for each process and mechanical system is 99.98%, excluding SWPF administrative processes.

17.3.3 Maintainability

Based on industry practice and the degree of diagnostic capabilities in modern control systems, a target MTTR of four hours to diagnose and repair faults is achievable, excluding administrative processes.

Processes within the SWPF and off-gas processes are expected to operate 24 hours per day for 365 days per year. Control systems for these processes have been engineered to ensure that maintenance (including software or hardware upgrades) can be performed with minimal or no process interruption.

Control systems will be designed to maintain their reliability or availability targets for a commissioning schedule (1 to 2 years) and a production schedule of at least 10 years.

During control system design, consideration will also be given to the fact that the SWPF design life is 40 years (Section C.3.10 of the SWPF Contract[^3] and P-SWP-03-0613 (Letter to C. Smith [DOE-SR] from C. H. Terhune III [Parsons][^197]). Allowances will be considered for obsolescence upgrades with minimal operational impact.
17.4  Closed-Circuit Television System

CCTVs will be installed in selected areas within the Process Building. Process Cells will have camera ports, but no permanently mounted cameras. The CCTVs will have pan, tilt, and zoom capability. The CCTV video images may be digitized and stored on disk. Real-time images will be displayed in the CR. CCTV monitoring will be provided at the following locations:

- Facility locations where constant surveillance of equipment is determined to be essential to safe and efficient operation of a process,
- The Operating Deck Bridge Crane and Filter removal system,
- Hot Cell, and
- Where required and prudent for facility operations and security.

17.5  Facility Access Control System

The Facility Access Control System utilizes a card swipe system. The system is in conformance with DOE O 151.1, *Comprehensive Emergency Management System*[^1] and will be used for onsite accountability. Personnel entering and exiting the facility at the access portal are required to card in and out. Personnel entering the process building will be required to card in to preclude unauthorized access.

17.6  Fire Detection and Alarm System

The facility is equipped with a fire detection and alarm system. See Section 15.0 for details.

17.7  Control System Power

The major components of the control system receive power from USX-301 (see Section 16.1.4 for a detailed description). The control systems include workstations, servers, switches, and ICPs. Each ICP has a dual power feed, one from USX-301 and the other from a non-UPS power panel. Where possible, field devices are loop/segment powered. Field devices may not be powered from the ICP, due to the power consumption or voltage requirements, but are powered from a 120V, 60-Hz source. Power for safety instruments is from a UPS, either USX-301 or a stand-alone local unit. Power for non-safety instruments is not required to be powered from the UPS; they will be connected to the UPS in locations where sufficient UPS power is available.

In addition, CAM/Area Radiation Monitor (ARM) monitoring equipment will be powered from USX-301. Servers in the Process Building will be connected to USX-301; however, no UPS will be provided for office workstations.

The fire detection and alarm system has independent, self-contained back-up power source, as required by NFPA requirements. The Public Address System is fed from normal power and each amplifier has a UPS system providing 30-minute back-up.
17.8 Continuous Air Monitors

Placement of CAMs within the SWPF shall be selected based on personnel accessibility, and the potential for change in airborne radioactivity concentrations due to the presence of radioactive material and/or processing equipment during operations, maintenance and/or upset conditions. The function of these monitors is to trend airborne radioactivity concentrations and provide real-time warning of abnormal conditions. Guidance for these decisions is provided in DOE-G-441.1-1c, Radiation Protection Program Guide for use with Title 10, Code of Federal Regulations, Part 835 Occupational Radiation Protection, Section 10.0 Air Monitoring. CAMs receive power via an UPS.

17.9 Area Radiation Monitors

Placement of ARM s within the SWPF shall be selected based on personnel accessibility, and the potential for change in area dose rates due to the presence of radioactive material and/or processing equipment during operations, maintenance and/or upset conditions. The function of these monitors is to trend area dose rates and provide real-time warning of abnormal conditions. Guidance for these decisions is provided in DOE-G-441.1-1C. ARM s receive power via an UPS.

18.0 DESIGN CRITERIA DATABASE

The Design Criteria Database (DCD) is an output of the design process, as described in P-PCD-J-00001 (SWPF Design Process Description). The purpose of DCD is to consolidate all radiochemical process requirements, regulatory requirements, safety requirements, interface requirements, and O&M requirements. This consolidation of requirements, in conjunction with P-DB-J-00003 and this document, serves as the basis for the SWPF design. The development process, sources, structure, and uses of the DCD are described in P-DB-J-00002.

19.0 REFERENCES

1 P-DB-J-00001, SWPF Basis of Design, Revision E. Parsons, Aiken, South Carolina.
4 P-CDM-J-00001, SWPF Configuration Management Plan, Revision 5. Parsons, Aiken, South Carolina.


8  P-DB-J-00002, SWPF Design Criteria Database, Revision 1. Parsons, Aiken, South Carolina.

9  S-RCP-J-00001, SWPF Standards/Requirements Identification Document (S/RID), Revision 2. Parsons, Aiken, South Carolina.

10 S-EIP-J-00001, SWPF Environmental Plan, Revision 2. Parsons, Aiken, South Carolina.

11 S-SAR-J-00001, SWPF Preliminary Documented Safety Analysis, Revision 0. Parsons, Aiken, South Carolina.


16 V-ESR-J-00004, SWPF Stormwater Interface Control Document (ICD-04), Revision 1. Parsons, Aiken, South Carolina.


18 V-ESR-J-00006, SWPF Liquid Sanitary Wastes Interface Control Document (ICD-06), Revision 1. Parsons, Aiken, South Carolina.


20 V-ESR-J-00008, SWPF Electrical Power Distribution Interface Control Document (ICD-08), Revision 5. Parsons, Aiken, South Carolina.


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62 P-ESR-J-00002, SWPF Project Structural Acceptance Criteria, Revision 3. Parsons, Aiken, South Carolina.


98 C-CF-J-0001, *SWPF Civil Overall Underground Electrical, Lighting and Communications Plan*, Revision 6. Parsons, Aiken, South Carolina.


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195 P-ESR-J-00003, SWPF Operations Assessment and Tank Utilization Models, Revision 0. Parsons, Aiken, South Carolina.


200 P-PCD-J-00001, SWPF Design Process Description, Revision 0. Parsons, Aiken, South Carolina.