SALT WASTE PROCESSING FACILITY

COMMISSIONING PLAN

DELIVERABLE 5.1

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Phase II

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SUMMARY OF CHANGES

Revision No.	Date	Description of Change
0	4/25/2011	Developed per DMR 1438. Initial Issuance (Contract Deliverable).
1	9/19/2016	Revised per DMR 3340 as a periodic review.
2	12/19/2018	Revised per DMR 4003 to address the current Project approach to the next phase of testing, Commissioning, and Hot Operations of the SWPF. This is a complete rewrite. No revision bars shown.

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LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
AFP	Alpha Finishing Process
Al	Aluminum
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
AOP	Abnormal Operating Procedure
APA	Air Pulse Agitator
ASDT	Alpha Sorption Drain Tank
ASME	American Society of Mechanical Engineers
ASP	Alpha Strike Process
AST-A	Alpha Sorption Tank-A
ATO	Authorization to Operate
AVD	Attribute Verification Database
BOBCalixC6	Calix[4]arene-bis(tert-octylbenzo-crown-6)
BPCS	Basis Process Control System
CAT	Construction Acceptance Testing
CCA	Cold Chemicals Area
CCR	Competence Commensurate with Responsibility
CD	Critical Decision
CF	Concentration Factor
CFF	Cross-flow Filter
CFR	Code of Federal Regulations
CG&A	Calibration, Grooming, and Alignment
CM	Configuration Management
CMMS	Computerized Maintenance Management System
CORR	Contractor Operational Readiness Review
CPR	Construction Project Review
CRAD	Criteria, Review and Approach Document
CRB	Commissioning Review Board
CRD	Contractor Requirements Document
Cs	Cesium
CSE	Cognizant System Engineer
CSS	Clarified Salt Solution
CSSX	Caustic-Side Solvent Extraction
CTL	Chronological Test Log
DCN	Design Change Notice
DCPT	Design Capacity Performance Test
Dcs	Cs Distribution Coefficients
DF	Decontamination Factor
DHEC	Department of Health and Environmental Control
DOE	U.S. Department of Energy
DOE ORR	DOE Operational Readiness Review

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

DOE-SR	U.S. Department of Energy-Savannah River
DOT	U.S. Department of Transportation
DSA	Documented Safety Analysis
DSS	Decontaminated Salt Solution
DSSHT	Decontaminated Salt Solution Hold Tank
DWPF	Defense Waste Processing Facility
EAL	Emergency Action Level
EOC	Emergency Operations Center
EOP	Emergency Operating Procedure
EPC	Engineering, Procurement, and Construction
EPCDC	Engineering, Procurement, and Construction Document Control
ERO	Emergency Response Organization
ESH	Environmental, Safety, and Health
FAT	Factory Acceptance Testing
FCN	Field Change Notice
FOSC	Facility Operations Safety Committee
g/cc	Grams per Cubic Centimeter
g/L	Grams per Liter
HEPA	High-Efficiency Particulate Air
HNO_3	Nitric Acid
HPS	Health Physics Society
HTF	H-Tank Farm
HVAC	Heating, Ventilation, and Air Conditioning
HW	Hazardous Waste
ICD	Interface Control Document
IH	Industrial Hygiene
IP	Implementation Plan
IVR	Implementation Verification Review
ISMS	Integrated Safety Management System
ISOT	Integrated System Operational Test
IWR	Integrated Water Run
JHA	Job Hazards Analysis
JTG	Joint Test Group
K^+	Potassium
KPP	Key Performance Parameter
lbs/gal	Pounds per Gallon
LLW	Low-Level Waste
LWO	Liquid Waste Operations
M	Molar
M&O	Management and Operating
mg/L	Milligrams per Liter
Mgal/yr	Million Gallons per Year
MSA	Management Self Assessment

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

MST	Monosodium Titanate
MW	Mixed Waste
NaOH	Sodium Hydroxide (Caustic)
NMMP	Nuclear Maintenance Management Program
NO_3^-	Nitrate
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
OH^-	Hydroxide
OJT	On-the-Job Training
ORR	Operational Readiness Review
pCi/mL	PicoCuries per Milliliter
PDSA	Preliminary Documented Safety Analysis
PITS	Performance Improvement Tracking System
POA	Plan of Action
PPD	Project Position Description
ppm	Parts per Million
PVT	Process Verification Test
QA	Quality Assurance
QC	Quality Control
RAT	Readiness Assistance Team
RCAB	Readiness Certification Assurance Board
RCRA	Resource Conservation and Recovery Act
RLW	Radioactive Liquid Waste
RPP	Radiation Protection Program
RPPM	Radiation Protection Program Manager
RR	Readiness Review
RSW	Radioactive Solid Waste
SAA	Startup Authorization Authority
SAT	Systematic Approach to Training
SBIP	Safety Basis Implementation Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SE	Strip Effluent
SEHT	Strip Effluent Hold Tank
SER	Safety Evaluation Report
SME	Subject Matter Expert
SNR	Startup Notification Report
SOP	Standard Operating Procedure
SOT	System Operational Test
SPF	Saltstone Production Facility
Sr	Strontium

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

SRS	Savannah River Site
SS	Safety Significant
SSC	Structure, System, and Component
SSFT	Salt Solution Feed Tank
SSRT	Sludge Solids Receipt Tank
SWPF	Salt Waste Processing Facility
T&Q	Training and Qualification
TDR	Test Deficiency Report
TIM	Training Implementation Matrix
TRU	Transuranic
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question
WAC	Waste Acceptance Criteria
WWHT	Wash Water Hold Tank
wt%	Weight Percent

1.0 INTRODUCTION

1.1 Overview

Under Contract DE-AC09-02SR22210, *Design, Construction, and Commissioning of a Salt Waste Processing Facility [SWPF]*[1], the U.S. Department of Energy (DOE) selected Parsons as the Engineering, Procurement, and Construction (EPC) Contractor to design, construct, and commission the SWPF at the Savannah River Site (SRS), and then operate the SWPF in Hot Operations for one full year. Following the one year of Hot Operations, SWPF operations will be transitioned to a selected Long-term Operating Contractor for continued facility operation.

During the construction phase, the SWPF Commissioning and Testing and Plant Operations organizations prepared for Commissioning and provided construction support by witnessing selected Factory Acceptance Testing (FAT) of the components to be installed in the plant, and participating in and supporting Construction Acceptance Testing (CAT). As construction progressed, jurisdictional control of completed structures, systems, and components (SSCs) transferred to Commissioning and Testing. Construction was declared complete following the satisfactory completion of the system turnover process for all systems in accordance with PP-CM-8103, *SWPF System Turnover from Construction to Commissioning*[2].

Following completion of construction, a series of test phases commenced with each phase requiring a more complex level of performance demonstration. The most basic level of testing was the Calibration, Grooming, and Alignment (CG&A) phase which included calibration checks of instrumentation and controls, functional checkout of control circuits, and initial component testing and operation.

The next phase of testing, System Operational Testing, demonstrated the overall ability of plant systems to meet their intended performance and functional requirements. Once the systems associated with a major unit operation (Alpha Strike Process [ASP], Caustic-Side Solvent Extraction [CSSX], and Alpha Finishing Process [AFP]) successfully completed System Operational Testing, Integrated System Operational Tests (ISOTs) were conducted to demonstrate the integrated operation and control of the multiple systems that are required to perform major unit operations in the plant.

Upon completion of the ISOT phase, the Integrated Water Run (IWR) testing commences. The IWR phase testing initially operates the plant as a complete unit to the extent possible using only water and then transitions to chemical testing in preparation for Cold Commissioning.

After completed Peer Review/Quality Assurance (QA) Review of System Operational Tests (SOTs) and ISOTs, and concurrent with or before the completion of water runs and Management Self Assessment (MSA)-2, the SWPF Project Manager will approve formal Plant turnover to the Operations group. Following transfer of plant jurisdictional control to Operations and a satisfactory MSA non-radioactive waste simulant and process chemicals, including CSSX solvent, will be introduced into the facility. The balance of tests requiring density-adjusted waste simulant and process chemicals will then be performed. Subsequent to successful completion of testing and systemization of the CSSX System, the IWR phase will conclude and Cold

Commissioning tests will commence. Process verification testing will be performed at full-scale operations with actual plant equipment using the non-radioactive waste simulant and the normal contingent of cold chemicals. The primary objectives of Cold Commissioning tests are to train the SWPF staff, verify the facility can meet the contractual performance requirements, demonstrate the design capacity for the unit operations, and determine the facility operating characteristics under routine and off-normal operating conditions. The detailed objectives for the Commissioning period, as defined in Standard 5(a), of the Contract[1], are to demonstrate:

1. *Process and facility performance meets or exceeds Contract requirements.*
2. *Adequate and correct procedures and safety limits exist for operating the process systems and utility systems.*
3. *Training and qualification programs for operations and operations support personnel are established, documented, implemented, and encompasses the required range of duties and activities (formal qualification is not applicable to all support personnel).*
4. *SWPF safety and environmental compliance documentation is in place and describes the safety and environmental compliance basis of the SWPF.*
5. *Program(s) are in place to confirm and periodically reconfirm the condition and operability of safety systems, including important to safety process systems and safety related utility systems.*
6. *Processes are established to identify, evaluate, and resolve deficiencies and recommendations made by DOE oversight groups, official review teams, and audit organizations.*
7. *Management programs are established, sufficient numbers of qualified personnel are provided, and adequate facilities and equipment are available to support those functions required for commissioning. These activities shall continue through to the Contractor's turnover to DOE and/or the long-term operations contractor (e.g., training, maintenance, waste management, environmental protection, industrial safety and hygiene, radiological protection and health physics, emergency preparedness, fire protection, QA, S&S, criticality safety, and engineering) are adequate for operations.*
8. *Functions, assignments, responsibilities, and reporting relationships are clearly defined, understood, and effectively implemented with line management responsibility for control of safety.*
9. *SWPF systems and procedures, as affected by facility modifications, are consistent with the description of the facility, procedures, and accident analysis included in the safety basis.*
10. *Modifications to the facility have been reviewed for potential impacts on procedures, training, and qualification. Procedures have been revised to reflect these modifications and training has been performed to these revised procedures. The SWPF design documentation is complete.*

SWPF will perform MSAs in order to ensure an orderly transition from Construction to Testing, then testing with chemicals and finally Hot Operations. The MSAs include:

- MSA-1, Ready to Test. This MSA verified readiness to commence the startup testing program. The verification review included testing program processes and procedures, the availability of qualified personnel, and the availability and readiness of facilities and equipment to support testing activities. At the conclusion of MSA-1, and with the Project Manager's approval, SWPF transitioned from programs based upon 29 Code of Federal Regulations (CFR) 1926, *Safety and Health Regulations for Construction*[3], to programs based upon 29 CFR 1910, *Occupational Safety and Health Standards*[4].

- MSA-2, Ready to Operate with Chemicals. MSA-2 commenced during SOT/ISOT testing. MSA-2 verifies Project readiness in two phases. Phase 1 supported the safe loading and handling of chemicals in the Temporary Tank Farm. Phase 2 will support testing the facility with process chemicals and process waste simulant.

  When the necessary elements of MSA-2 were successfully completed and with the Project Manager's approval, bulk chemical loading into the Temporary Tank Farm was performed (Phase 1). When the remaining elements of MSA-2 are completed, the non-radioactive waste simulant and process chemicals, including CSSX solvent, will be introduced into the facility (Phase 2). This MSA will verify readiness to safely operate the facility with process chemicals and caustic waste simulant. The Integrated Safety Management System (ISMS) Phase 1 Verification for operational activities will also be performed.

- MSA-3, Ready to Operate. This MSA will focus on verifying that the SWPF is ready to safely and compliantly operate as prescribed in DOE O 425.1D Chg. 1, *Verification of Readiness to Start up or Restart Nuclear Facilities*[5], and DOE-STD-3006-2010, *Planning and Conducting Readiness Reviews*[6]. That is, the plant would promptly start nuclear operations if there were no requirements for Operational Readiness Reviews (ORRs) because it is truly ready to operate. SWPF will perform an Implementation Verification Review (IVR) of the safety basis prior to making the declaration of implementation. The IVR is a rigorous review of the readiness to declare implementation of the safety basis and may be performed coincident with MSA-3. The approach is to perform the IVR as a readiness review using DOE-STD-3006-2010[6] as a guide. Following the successful completion of the IVR, safety basis implementation will be declared per the requirements of PL-NS-5500, *SWPF Safety Basis Implementation Plan*[7] (SBIP).

At the successful conclusion of MSA-3 and in accordance with the approved Plan of Action (POA), the Plant Manager will issue a Readiness to Proceed Memorandum to request a Contractor Readiness Review (CORR). This CORR, to be conducted during Cold Commissioning, will be performed as required by DOE O 425.1D Chg. 1[5].

Following satisfactory completion of the CORR, the SWPF Project Manager will forward a Readiness to Proceed Memorandum to the DOE SWPF Federal Project Director, indicating that readiness to start operations has been achieved. A manageable list of open pre-start issues may exist and any pre-start issues will include a well-defined schedule for closure. The DOE

Operational Readiness Review (DOE ORR) will be separate and independent from the CORR, and will likely include areas assessed in the CORR, including any identified areas of weakness.

After completion of the CORR, the DOE ORR, and closure of pre-start findings, EPC management will solicit SWPF startup authorization from the DOE Startup Authorization Authority (SAA). In addition, the preparation and completion of the hot-tie in with the existing waste transfer will be made. This work will occur under strict configuration control and in coordination with the SRS Liquid Waste Operations (LWO) Contractor. Upon receiving startup authorization, the EPC will request the SRS LWO Contractor to transfer the first mini-batch of feed to the SWPF. In accordance with Section C, Standard 5 of the Contract[1], Testing activities to be performed for Hot Commissioning include Process Capacity Performance Testing, Radiation Shielding Performance Testing, and Environmental Performance Testing.

Per the Contract[1], Critical Decision (CD)-4 for the SWPF Project is defined as Approve Start of Operations. It is predicated on the readiness of the operators to operate and maintain the facility. Starting operations does not terminate project activity. SWPF Project closeout is a post CD-4 activity.

1.2 SWPF Description

The SWPF is designed to receive SRS Radioactive Liquid Waste feed directly from the Radioactive Liquid Waste Feed Tank. Liquid waste that contains concentrations of Cesium (Cs), Strontium (Sr), actinides, and other chemical/radionuclide constituents is transferred to the SWPF in mini-batches of nominally 23,200 gallons once every 20 to 24 hours.

SWPF processing consists of three unit operations: ASP, CSSX, and AFP. In the ASP stage, Sr and actinides are adsorbed onto monosodium titanate (MST) and the resultant slurry is filtered to remove the MST and insoluble solids. The ASP is a batch process in which MST is added to the waste feed solution and then reacted for 6-12 hours. The mixed slurry is then filtered to reach a solids concentration of approximately five (5) weight percent (wt%) based on incoming solids of 600 milligrams per liter (mg/L). The MST and insoluble solids (MST/sludge) are washed and sent to the Defense Waste Processing Facility (DWPF) for vitrification. The filtrate, known as Clarified Salt Solution (CSS), is sent to the second unit operation, CSSX, for Cs removal.

The second SWPF unit operation uses a CSSX process to remove Cs from the salt solution. This is a continuous flow process utilizing 36 centrifugal contactor stages for extraction, scrubbing, washing, and stripping of aqueous and organic streams. The Cs is captured by contacting the aqueous CSS with a specially engineered extractant (BOBCalixC6) in an organic phase. After extraction, the organic is scrubbed with Nitric Acid (HNO_3) to remove Sodium (Na) and other non-radioactive salt constituents. The Cs is then stripped from the organic phase by contacting the organic with a strip solution (dilute HNO_3). The strip effluent (SE) product stream (containing a high concentration of Cs) is sent to the DWPF for vitrification. The Decontaminated Salt Solution (DSS) product stream from the extraction section is sent to H-Tank Farm (HTF) Tank 50 and then to the Saltstone Production Facility (SPF) to be solidified with a cementitious grout mixture and disposed of as a solidified mass in engineered vaults.

Finally, the stripped organic solvent undergoes a Caustic Wash treatment prior to return to the Solvent Hold Tank and eventual reuse.

The final unit operation, AFP, provides an additional MST strike to remove any residual Sr and actinides that may exceed the Tank 50/SPF Waste Acceptance Criteria (WAC). This step will only be used if the Cs-depleted DSS stream does not meet the Tank 50/SPF WAC requirements. Although the ASP and AFP operations are mechanically similar, the primary difference between these operations is that the CSSX operation removes Cs-137 before the AFP. This results in much lower radioactivity levels in the AFP. These lower activity levels enable contact handling of the processing equipment. The large, heavily shielded process cells used for the ASP are not required in the AFP. In addition, the actual batch time for mixing MST with the feed is expected to be less than in the ASP operation.

Even though unit operations for the SWPF use proven processes and equipment, variability in feed composition and related interferences require proficient control of the process chemistry to ensure facility performance. The feed batches received by the SWPF are sampled and analyzed to determine the operational steps and time sequencing to produce DSS, MST/sludge, and SE products that meet specifications. In-process radiochemical measurements are necessary to ensure proper control and operation of the ASP, CSSX, and AFP. These operations require both continuous inline measurements and periodic analyses of process samples. Analysis of process samples will be performed by SWPF Analytical Laboratory personnel in the SWPF Analytical Laboratory.

1.3 Commissioning Plan Purpose and Objective

The purpose of this Commissioning Plan is to fulfill the Standard 5(b) Contract[1] Commitment that:

> "*The Contractor shall prepare a detailed Commissioning Plan for DOE review and approval (Table C.5-1.1, Deliverable 5.1) prior to the start of commissioning; the Plan shall be submitted a minimum of 12 months prior to the introduction of waste feed simulant into the SWPF. The Plan shall, at a minimum, define the SWPF organization, specific tests, and procedures for Commissioning the SWPF.*
>
> *The Plan shall define how Commissioning test objectives will be met and how the SWPF will transition to fully operational radioactive status, which will demonstrate the design criteria, process, safety, process and product control features, and the environmental safety requirements of the Contract.*
>
> *The Plan shall identify the system acceptance and operability criteria by which that system will be released to support other systems. The Commissioning Plan shall be updated and provided to DOE for approval as required."*

The overall objective of this Commissioning Plan is to provide a description of the major processes and programs that have been, or will be, implemented by the SWPF to meet the applicable requirements, and to demonstrate readiness for the SWPF to enter Hot Operations as

a Hazard Category 2 Nuclear Facility. This Plan provides a summary-level description of each program element, how it will be implemented, and how the individual elements will be integrated. More detailed descriptions for the activities to be performed are provided in lower-tier plans and procedures, many of which are referenced in this Plan. Table 1-1, *Commissioning Key Project Documents*, shows the relationship between the Commissioning Plan and other key Project plans and procedures. Some of the Project documents listed in Table 1-1 are in development, archived, or subject to change as Project needs evolve.

Table 1-1. Commissioning Key Project Documents

Commissioning Plan Section		Document Number	Document Title
2.0	SWPF Commissioning and Plant Operations Organizations	V-IM-J-00001	SWPF Organization, Roles, and Responsibilities Manual
3.0	SWPF Startup Testing and Commissioning Program	V-PMP-J-00009	Key Performance Parameter (KPP) Validation Plan
		S-CIP-J-00006	Integrated Construction and Acceptance Testing Program
		PL-CM-8007	Distributed Control System/Instrumentation and Controls Project Plan
		PL-CM-8010	SWPF SOT Plan
		PP-OP-8515	Jurisdictional Turnover From Commissioning/Testing to Plant Operations
		CGA-PLN-001	SWPF Calibration, Grooming and Alignment (CG&A) Plan
		PL-CM-8012	SWPF ISOT Plan
		PP-CM-8018	Commissioning Review Board
		PP-CM-8019	Conduct of Testing
		PP-CM-8102	Startup Test Procedure Administration
		PP-CM-8103	SWPF System Turnover from Construction to Commissioning (ARCHIVED)
		PP-CM-8104	Turnover Punch List Item Processing (ARCHIVED)
		PP-CM-8107	Joint Test Group
		DP-CM-8010	Test Results Review and Approval
		DP-CM-8013	CG&A Procedure Administration and Use
		P-ESR-J-00013	SWPF Analytical Laboratory Operations Plan
		PP-EN-5027	Attribute Verification Database Procedure
		P-SUP-J-00004	Process Verification Testing Plan
		P-SUP-J-00005	Design Capacity Performance Test Plan

Table 1-1. Commissioning Key Project Documents (cont.)

Commissioning Plan Section		Document Number	Document Title
3.0	SWPF Startup Testing and Commissioning Program	P-SUP-J-00003	Off-Standard Test Plan
		P-SUP-J-00002	Environmental Test Plan
		PL-CM-8014	SWPF Integrated Water Run Test Plan
		PL-OP-8538	SWPF Cold Commissioning Chemical Loading Plan
		PL-OP-8535	CSSX Systemization Plan
		PL-OP-8539	Plant Performance Test Plan
4.0	SWPF Maintenance Program	V-PMP-J-00062	Nuclear Maintenance Management Program Description Document
		PL-MN-8701	SWPF Maintenance Trial Test Plan
		PL-MN-8704	SWPF Nuclear Maintenance Management Program Plan
5.0	SWPF Training and Qualification Program	PL-TR-1801	SWPF Personnel Selection, Training, and Qualification Plan
		PL-TR-1802	SWPF Operations Training Program Description
		PL-TR-1803	SWPF Maintenance Training Program Description
		PL-TR-1804	SWPF Laboratory Training Program Description
		PL-TR-1805	SWPF Cognizant System Engineer Training Program Description
		PL-TR-1806	SWPF Radiation Protection Personnel Training Program Description
		PL-TR-1807	SWPF Safety/Industrial Hygiene Training Program Description
		PL-TR-1808	SWPF Quality Assurance/Quality Control Training Program Description
		PL-TR-1809	SWPF Instructional Staff Training Program Description
		PL-TR-1810	SWPF Software Quality Assurance Training Program Description
		PL-TR-1813	SWPF Engineering Technical Staff Training Program Description
		PL-TR-1814	SWPF Shift Technical Engineer Training Program Description
		PL-TR-1816	SWPF Manager and Supervisor Training Program Description
		DP-CM-8200	Test Engineer Qualification
		PP-TR-1801	Training or Qualification Requirement Exceptions or Extensions
		PP-TR-1802	Employee Indoctrination and Training
		PP-TR-1803	Selection of Personnel for SWPF Job Positions

Table 1-1. Commissioning Key Project Documents (cont.)

Commissioning Plan Section		Document Number	Document Title
6.0	SWPF Conduct of Operations Program	P-ESR-J-00011	SWPF Operations Requirements Document
		PL-OP-8503	SWPF Conduct of Operations Implementation Plan
		P-CMP-J-00001	SWPF Conduct of Operations Manual
		PL-OP-8521	SWPF Plant Operations Staffing Plan
		PL-OP-8530	SWPF Plant Proficiency Plan
7.0	SWPF Environmental, Safety and Health Program	PM-OP-8501	SWPF Operations Safety Manual
		Q-PLN-J-0100	SWPF Environmental Management Systems Program Description
		S-CIP-J-00003	SWPF 10 CFR 851 Worker Safety and Health Plan
		P-EIP-J-00001	SWPF Integrated Safety Management System Description
		PL-SH-4300	SWPF Industrial Hygiene Program Plan
8.0	SWPF Emergency Preparedness Program	PL-OP-8515	SWPF Emergency Preparedness Implementation Plan
9.0	Safety Basis Approval and Implementation	S-SAR-J-00001	Preliminary Documented Safety Analysis
		S-SAR-J-00002	SWPF Documented Safety Analysis
		S-TSR-J-00001	SWPF Technical Safety Requirements
		PL-NS-5500	SWPF Safety Basis Implementation Plan
10.0	SWPF Quality Assurance Program	V-QP-J-00001	SWPF Quality Assurance Plan
11.0	SWPF Fire Protection Program	F-PP-J-00001	SWPF Fire Protection Program Plan
12.0	SWPF Waste Management Program	V-WCP-J-00002	Radioactive Waste Management Basis
		V-WCP-J-00003	SWPF Waste Certification Plan
13.0	SWPF Radiation Protection Program	S-CIP-J-00004	Radiation Protection Program for 10 CFR 835 (Occupational Radiation Protection)
		PL-OP-8524	SWPF Plant Operations Radiological Mock-up Plan
14.0	SWPF Cognizant System Engineering Program	P-ESR-J-00035	SWPF Cognizant System Engineering Plan
16.0	Startup Plan	V-PMP-J-00041	SWPF Startup Plan
17.0	Transition to Hot Operations	V-PMP-J-00042	SWPF Transition to Hot Operations Plan
18.0	Cyber Security	V-PMP-J-00046	SWPF Plant Control and Monitoring System Information System Security Plan

1.4 Document Control

This Commissioning Plan will be updated as needed as the SWPF Commissioning and Testing and Plant Operations organizations, programs, requirements, and methods are developed and/or matured.

2.0 SWPF COMMISSIONING AND PLANT OPERATIONS ORGANIZATIONS

The majority of commissioning work will be performed initially by the Commissioning and Testing group, and later by the Plant Operations group. For a more in-depth discussion of the SWPF Commissioning and Testing and the Plant Operations organizations, refer to V-IM-J-00001, *SWPF Organization, Roles, and Responsibilities Manual*, Section 3.0 "Plant Operations"[8]. A detailed analysis, as reflected in PL-OP-8521, *SWPF Plant Operations Staffing Plan*[9], has been conducted for the activities that need to be performed to commission and operate the facility. The analysis included the planned structure and staffing of the Commissioning and Testing and Plant Operations organizations, as well as such support organizations as Environmental, Safety, and Health (ESH). Plant organizations will be staffed as described below for the commissioning of the SWPF. The staffing structure may change as operational requirements and needs are further developed. Commissioning work will also be supported by other SWPF organizations. Summaries of these support organizations are provided in Section 2.3.

Plant Operations, with Commissioning and Testing group support, will process chemicals in the latter part of IWR and Cold Commissioning testing. Plant Operations will perform proficiency activities and readiness review activities through completion of the DOE ORR and Hot Operations upon approval from DOE. Proficiency activities are described in detail in PL-OP-8530, *SWPF Plant Proficiency Plan*[10]. Additionally, the approach for execution of PL-OP-8530[10] is described in Memo 00-700-26647, *Approach for Execution of Reference 1*[11], dated 7/11/18.

2.1 Commissioning and Testing Group

The current staff organization for the Commissioning and Testing Organization during Startup is available on Salt Project Collaboration Portal. This group will accept the turnover of systems from Construction; test the components, systems, and integrated systems; and, finally turnover the plant to the Plant Operations group. Commissioning and Testing group personnel will be qualified as described in Section 2.1.1.

2.1.1 Test Engineer Qualification

A Test Engineer Qualification Program that complies with the requirements cited in American Society of Mechanical Engineers (ASME) NQA-1, *Quality Assurance Requirements for Nuclear Facility Application*, Appendix 2A-1, *Non-mandatory Guidance for the Qualification of Inspection and Test Personnel*,[12] is implemented by DP-CM-8200, *Test Engineer Qualification*[2].

Three levels of Test Engineers (Level I, Level II, and Level III), are utilized, the minimum core requirements for qualification at each level, and the functions and activities that each level is

authorized to perform will be defined. The Commissioning and Testing Manager will qualify the Test Engineering Manager. The Test Engineering Manager will qualify the Lead Test Engineers and Test Engineers based on an evaluation of the individual's education, experience, and training. Lead Test Engineer and Test Engineer qualification will be re-evaluated as required by DP-CM-8200[2].

Experienced test engineers who were involved in the early phase Engineering, Design and Development Testing Program, the CSSX and Cross-flow Filter Full-scale System Testing, the Reliability and Maintenance Evaluation Testing Program, and the Air Pulse Agitator (APA) Testing have transitioned to the Startup Testing and Cold Commissioning Phases. These experienced personnel, supported by newly recruited engineers, will prepare the required test procedures, assist in the turnover process and perform the startup testing.

2.2 Plant Operations Group

The Operations organization will be initially staffed to support the Commissioning and Testing group in conduct of startup testing activities. The Operations group will be fully staffed prior to the IWR period and ready to support four shift 24/7 operations during Cold Commissioning. The group consists of Management, Shift Operations Managers, Shift Technical Engineers, Control Room Operators, Field Operators, Operations Coordinators, and various support personnel.

2.2.1 Operations

The Operations organization will be initially staffed to support the Commissioning and Testing group in conduct of startup testing activities. The Operations group will be fully staffed prior to the IWR period and ready to support 24/7 operations during Cold Commissioning. The group consists of Management, Shift Operations Managers, Shift Technical Engineers, Control Room Operators, Field Operators, Operations Coordinators, a Procedures group, and various support personnel.

2.2.2 Laboratory

The SWPF Laboratory will support Commissioning during Pre-cold Commissioning, Cold Commissioning and Hot Commissioning phases with analyses of feed materials, product and waste streams. This support will initially be chemical analyses and later, during hot commissioning, both chemical and radio-chemical analyses. The Laboratory is currently planned to consist of: Laboratory Supervisor, Lead Chemist, Chemists, Laboratory Production Supervisor, Laboratory Technicians, Laboratory Information Management System Administrator, and Laboratory Clerk.

2.3 Support Organizations

2.3.1 Environmental, Safety, & Health and Quality

During Commissioning, the ESH and Quality organizations will provide Subject Matter Experts (SMEs) for radiological protection, health physics, environmental compliance, occupational safety, industrial hygiene (IH), quality control (QC), and QA, along with the corresponding

supervisory/management functions. The level of support has been planned as an integral element of the baseline development process and the roles/responsibilities are procedurally identified. The Radiation Protection staff will be assigned to each shift to ensure continuous radiological monitoring and assistance during Hot Commissioning as well as during most Cold Commissioning preparation activities.

2.3.2 Engineering

The Engineering organization will provide SME and Cognizant System Engineer (CSE) support throughout the Commissioning phase. Engineering will also provide technical input into determining testing requirements, developing suitable tests, resolving test deficiencies, and modifying plant design.

2.4 Commissioning Review Board

Standard 5(d) Contract[1] Commitment:

> *Commissioning Review Board: The Contractor will chair a Commissioning Review Board with DOE participation. The Site Contractor will participate during Hot Commissioning as required for interface activities. The Board will review the detailed plans, procedures, testing issues, commissioning progress, and results. The Commissioning Review Board shall meet, as necessary, until completion of commissioning activities. The Contractor shall be responsible for testing and commissioning the equipment and systems, as follows:*
>
> *(1) Demonstrate the correct functioning of systems important to safety;*
>
> *(2) Demonstrate site emergency procedures;*
>
> *(3) Test radiation instruments with sealed sources;*
>
> *(4) Test systems with density changes;*
>
> *(5) Start-up from an idle condition;*
>
> *(6) Sample and analysis systems;*
>
> *(7) Evaluate shielding;*
>
> *(8) Validate operations and maintenance procedures;*
>
> *(9) Train and qualify SWPF operators and maintenance personnel;*
>
> *(10) Perform all required system environmental tests;*
>
> *(11) Perform SWPF integrity and equipment inspections;*
>
> *(12) Demonstrate construction completeness; and*
>
> *(13) Demonstrate process and product control features.*

The Commissioning Review Board (CRB) is an organization composed of senior representatives from various functional organizations including DOE. The CRB is responsible for the review,

approval, and assessment of testing programs, procedures, and documents in support of the SWPF testing and commissioning effort. The CRB ensures that established test program performance objectives are adequately complete and satisfy applicable requirements.

2.5 Joint Test Group

The Joint Test Group (JTG) is a working-level group that functions as a technical advisory group to the CRB. The JTG membership is composed of representatives from Commissioning and Testing, Operations, QA, Engineering, ESH, and DOE. The JTG is responsible for performing thorough, detailed reviews of testing documentation including test plans, procedures, deficiencies, and results. It is through participation as a member of the JTG that QA establishes quality requirements for test documentation and execution.

3.0 SWPF STARTUP TESTING AND COMMISSIONING PROGRAM

The SWPF shall be proven acceptable to enter Hot Operations through a series of tests performed in distinct phases. Testing commenced with FATs and CATs carried out during the Construction phase, followed by simple component-level tests, progressing through system-level and integrated system-level tests, and continuing with more complex demonstrations at the facility level. Each phase of testing is designed to progressively verify the functions of the components and systems within the facility, resulting in a plant ready for transitioning into Hot Operations.

The sequencing of testing was initially based on selecting systems that are required to support the major unit operations. The testing of these support systems was performed early in the schedule so that they were operational and available to support the testing of the more complex systems.

This approach had the following benefits:

- Testing was performed simultaneously on multiple components within a system;
- Testing was performed simultaneously on multiple systems within the plant; and
- Design and component deficiencies were identified early during component and system testing, thereby providing the greatest probability that resolution of the deficiency would not impact the critical path schedule.

3.1 Identification of Test Requirements

Engineering determined and documented design, performance, functional, and safety test requirements and acceptance criteria at the component, system, and process levels. Such lower-level test requirements as CAT were approved by Engineering through the approval of equipment specifications. Approved test plans and procedures were provided to EPC Document Control (EPCDC) in accordance with Project procedures.

An Attribute Verification Database (AVD) was developed and is maintained by Engineering for identifying and tracking significant and measureable test requirements. Such design output

documents as drawings, data sheets, specifications, basis of design documents, automation functional control sequence documents, and the Preliminary Documented Safety Analysis (PDSA)/Documented Safety Analysis (DSA) were reviewed by Engineering to identify component- and system-level features that must be validated through testing. The Contract[1] and upper-tier contract deliverables were reviewed for system- and process-level requirements that also must be validated through testing. Once a test requirement was identified, Engineering entered the requirement into the AVD and tagged the requirement to a specific component or piece of equipment, or to a specific system. For requirements that must be validated by a test, when the test is completed and test results are approved, the identification of the document(s) providing objective evidence that the requirement was satisfied is entered into the database. Development and administration of the AVD is described in PP-EN-5027, *Attribute Verification Database Procedure*[2]. Objective evidence of test requirements being met will be presented to the JTG and the CRB for review and approval.

3.2 Construction Acceptance Tests

The CAT program is described in S-CIP-J-00006, *SWPF Project Integrated Construction and Acceptance Testing Program*[13]. CATs were performed by the organizational element performing the construction (i.e., CATs for subcontracted work were performed by the subcontractor) prior to the turnover of a system to Commissioning and Testing. CAT requirements for self-performed work were specified in Inspection Test Plans prepared by Engineering in accordance with PP-EN-5026, *Preparation of Inspection Test Plans*[2]. Inspection Test Plan requirements were translated into CAT procedures where required by specification, or in detailed work instructions developed by Construction, with select procedures reviewed by Commissioning and Testing. Construction documented test results on test report forms.

CAT requirements for subcontracted work were specified in engineering specifications referenced or contained in applicable procurement documentation. Subcontractors responsible for performing CATs developed CAT procedures, where required by the specification, or detailed work instructions that were reviewed by Commissioning and Testing and approved by Engineering prior to conducting the CAT.

Commissioning and Testing witnessed the conduct of selected subcontracted and self-performed CATs.

A listing of SWPF CATs is contained in Table 5-1 of P-ESR-J-00011, *SWPF Operations Requirements Document*[14].

3.3 System Turnover from Construction to Commissioning and Testing

The Commissioning and Testing staff segregated the SWPF plant into a number of testable systems and plant areas. The testable systems are defined as systems (or a cross-grouping of systems) that provide a functionally testable entity which can be isolated from other systems, whereas the plant areas represent specific buildings or areas within a building. These systems/plant areas formed the basis for determining the scope of each turnover system from

Construction to Commissioning and Testing, and were used to develop the turnover system boundaries.

Planned physical boundaries of the turnover systems have been defined on "system scoping" piping and instrumentation diagrams, electrical single-line drawings, Heating, Ventilation, and Air Conditioning (HVAC) flow diagrams, and other applicable design documents. These drawings showed the initial physical interface where the mechanical, electrical, controls, and support system boundaries occur, but varied as testing progressed and were used for initial designation of testing for planning purposes. Additionally, commodity lists (manual valves, specialty items, instruments, equipment, cables, pipe lines, and HVAC equipment) electronically linked to the configuration-managed technical baseline databases have been developed, with each entity being tagged to the appropriate system identifier so that a direct link between components and the system in which they are scoped exists. The system scoping drawings and the commodity lists define the system turnover boundaries and the scope of equipment and components contained within the system. These boundaries were clearly defined during the formal turnover process.

The process for turning over completed systems from Construction to Commissioning and Testing was administratively controlled by PP-CM-8103[2]. This document contains the contractual requirements for system turnover, and changes to PP-CM-8103[2] required mutual agreement between DOE and the EPC. This procedure established a structured turnover process that:

- Defined interface responsibilities;
- Provided for the identification and tracking of open items and deficiencies;
- Provided for a formalized acceptance of the turned-over system;
- Provided clear guidelines for marking jurisdictional boundaries; and
- Established a turn back process for construction rework, as needed.

The turn back process for construction rework is a formalized process that established the required controls and responsibilities for turn back of SSCs to Construction after jurisdictional control had been assumed by Commissioning and Testing. Under the turn back process, control of the system (or partial system) was formally transferred back to Construction, and Commissioning and Testing was not permitted to perform any testing or maintenance on the system. After completion of the rework and acceptance by Commissioning and Testing, control of the system was transferred back to Commissioning and Testing.

3.4 Declaration of Construction Complete

Construction complete was declared by SWPF via letter 00-700-24682, *SWPF Construction Complete Declaration*[15], and formally accepted by DOE via letter SWPF-16-223, *SWPF Acceptance of Parsons Construction Complete Declaration*[16].

3.5 Startup Testing

Standard 5(e) Contract[1] commitment:

> *Start-up Testing: After equipment has been installed in the facility and construction acceptance testing has been completed, systems will be tested to verify operational performance. Systems will be tested individually and as part of an integrated unit or grouping of systems. System Operational Tests (SOTs) will establish the performance baseline for each system for comparison to the design requirements. System interfaces and integrated unit operations will be tested using Integrated System Operational Tests (ISOTs). The SOTs and ISOTs will also be used to verify operator proficiency and to validate procedures for system start-up, shutdowns, normal, and abnormal operations. The SOTs and ISOTs (Table C.5-1.1 Deliverable 5.3A) will be approved by DOE through their participation in the Commissioning Review Board.*

3.5.1 Startup Test Plans and Procedures

Test Engineers qualified to Level II requirements of the Non-Mandatory Guidance for Qualification of Inspection and Test Personnel in ASME NQA-1 developed the necessary test plans and test procedures for the required CG&A tests, SOTs, and ISOTs. Format and contents of the procedures were standardized by the use of standardized templates.

CG&A test procedures are component-level test procedures that were written to test specific types of equipment (pumps, motors, valves, etc.) and were generic or component-specific. These procedures included component test data sheets upon which test results were recorded. The Test Engineering Manager and the Commissioning and Testing Manager were the final approval authority for both the component-level test procedures and test results reported on the component test data sheets. The approved component test data sheets are retained by EPCDC as quality records.

SOT and ISOT procedures are limited use procedures developed with the specific intent of providing documented objective evidence that the SWPF SSCs were correctly installed and capable of performing their intended functional, performance, and safety design attributes. SOT and ISOT procedures:

- Reflected the most current approved design;
- Identified the prerequisite activities that were performed before the test commenced;
- Provided step-by-step instructions for performing the test activities;
- Provided data sheets, tables, or blank spaces for recording data;
- Established the post-test restoration activities that were performed to leave the tested system in a safe configuration;
- Identified the acceptance criteria used to evaluate the success of the test; and

- Incorporated, utilized, and field validated to the extent possible the normal plant operating procedures for system startup, normal operations, and shutdown.

SOT/ISOT test procedures were validated typically by walking down the procedure prior to being executed in the field and were reviewed and recommended for approval by the JTG. Following JTG review, test plans and procedures are submitted to the CRB for final review and approval.

3.5.2 Conduct of Startup Testing

Conduct of testing is controlled by PP-CM-8019, *Conduct of Testing*[2]. This procedure establishes a uniformly controlled methodology for ensuring testing activities are performed in a safe and effective manner while considering non-mandatory guidance given in ASME NQA-1. This procedure defines testing responsibilities and establishes the controls for:

- Conducting a test;
- Maintaining a Chronological Test Log (CTL);
- Implementing test pauses, stops, and restarts;
- Performing retests;
- Recording and resolving test deficiencies;
- Troubleshooting; and
- Encountering an emergency or abnormal condition.

The performance of CG&A component-level tests, SOTs, and ISOTs were controlled and directed by Test Engineers qualified to ASME NQA-1 Level II requirements. The CG&A component-level tests, SOTs, and ISOTs may have been performed by Level I Test Engineers working under the supervision of Level II Test Engineers.

Startup testing will also support the following IWRs and Cold Commissioning testing activities:

- Systemization (CSSX, ASP, AFP, Cold Chemicals Area [CCA]),
- Plant Performance Testing,
- Process Verification Testing,
- Design Capacity Performance Testing,
- Off-Standard Operational Testing, and
- Environmental Performance Testing.

Prior to starting testing activities, the Level II Test Engineer responsible for directing the test ensures that a work package, including an approved Job Hazards Analysis (JHA) identifies the potential hazards associated with the conduct of the test and the controls that will be used to

eliminate or mitigate the hazards. In addition, authorization to begin testing must be received from the Test Operations Manager and the Shift Operations Manager.

If a test deficiency occurs, the Test Engineer will pause or stop testing, as required and initiate a Test Deficiency Report (TDR). Following approval from the Test Engineering Manager, testing may continue with unaffected sections of the test. Once the TDR has been dispositioned and approved, the Lead Test Engineer will implement the disposition and resume testing or retest the affected section.

In an emergency or abnormal condition, the Test Engineer is authorized to take appropriate action independent of the test procedure to place equipment in a safe and stable configuration.

3.5.3 Calibration, Grooming and Alignment Component Tests

CG&A was the first sequence of startup testing that occurred after a system had been turned over from Construction to Commissioning and Testing. This was an extensive phase of testing that continued almost through the full duration of the Startup Testing Phase. The objective of this basic level of testing was to test individual components, place them into service, and continue until components within a system were readied for service and the system could undergo a SOT.

Since the same types of components are found in multiple systems, a uniform testing standard and cost-minimization approach was realized through the use of "generic" test procedures that were developed for testing the same types of components across multiple systems. Any component not tested during CG&A component testing was tested during the SOT and/or ISOT phase. The following represents a typical list of component types that were tested using "generic" type procedures:

- Pumps and motors,
- Air operated valves,
- Manual valves,
- Dampers,
- Level instrumentation, and
- Flow instrumentation.

During this phase of testing, much of the testing of devices connected to the Basic Process Control System (BPCS) occurred. Instrument and control field devices were configured on the BPCS, calibrated, and checked for proper operation. Such solid-state devices as variable frequency drives and overcurrent protection devices were programmed. Control circuit functional tests were performed to verify proper sequencing of operations and interlock functions, and field devices were placed into service.

During the CG&A phase, mechanical and electrical equipment underwent initial operation and testing to verify conformance with product specifications. The initial startup and testing of packaged systems (air compressors, chilled water units, etc.) where specifications required the

vendor to perform the work, and the testing of material handling equipment where specifications required the vendor to test the equipment and place it into service, occurred during the CG&A phase. Commissioning and Testing was responsible for reviewing and approving vendor test procedures and final test reports and for witnessing these tests, as appropriate.

During the CG&A phase, maintenance procedures for instrument calibration checks and surveillance checks were finalized and validated. This phase of testing also provided a significant opportunity to conduct on-the-job training (OJT) for the Plant Operations and Maintenance (O&M) staff through their participation in and observation of these activities.

3.5.4 System Operational Tests

SOTs demonstrated that each system performed as designed and the performance, functional, and safety design attributes were met. SOTs were conducted by Test Engineers with support from Plant O&M personnel and used operating procedures, to the extent possible. This provided OJT opportunities for the Plant Operations staff and, to the extent possible, for the verification and validation of plant operating procedures. The test fluid used was water.

The list of SOTs is provided in Appendix A, *System and Integrated System Operational Tests*.

3.5.5 Integrated System Operational Tests

After systems associated with a major unit operation were operationally tested, ISOTs were conducted. ISOTs demonstrated integrated operation and control of multiple systems or subsystems that are required to perform a major unit operation in the plant. Control, safety, and plant protection features, as well as full throughput with water where possible, were demonstrated. ISOTs were conducted by Test Engineers with support from Plant O&M personnel and used operating procedures, to the extent possible. This provided additional OJT opportunities for Plant Operations staff and, to the extent possible, for the verification and validation of operating procedures. ISOTs verified that integrated system alignment, grooming, processes, and operations were sufficient to proceed with further testing. This testing activity represented the final building block for delivery of a completed, fully functional unit operation ready to support IWRs.

The list of ISOTs is provided in Appendix A.

3.5.6 Approval of Test Results

Upon completion of a test, the Test Engineer prepares a test package comprised of the completed procedure and attachments, the CTL, completed TDRs, and a test report summary. The completed package is peer reviewed by a qualified Test Engineer prior to being submitted for final review and approval. Test packages are reviewed by the JTG. Following JTG review, test packages are submitted to the CRB for final approval.

If Engineering, supported by the Commissioning and Testing Manager, determines that the test results did not meet the relevant requirements, one of the following actions must be performed:

- Use-as-is: The determination has been made that the test deficiency will not impact SWPF Operations or ESH and Quality compliance. A written justification for the use-as-is disposition will be prepared and approved by Engineering.
- Rework and Retest: The determination has been made that the test deficiency can be resolved by reworking the equipment and returning it to its original design condition. The affected portions of the test will then be re-performed.
- Design Change: The determination has been made that the test results indicate that a design change is appropriate to address the test deficiency. The approval/closure of the Design Change Notice (DCN) and associated retest or Post-Maintenance Testing shall be tied to a specific milestone.

Approved SOT and ISOT test packages were submitted to DOE for information purposes to meet Contract Deliverable 5.3A[1] requirements.

3.5.7 Laboratory Instrumentation Testing

The SWPF Analytical Laboratory personnel must be prepared to perform required analysis to support IWR, Cold Commissioning, and Hot Commissioning per P-ESR-J-00013, *SWPF Analytical Laboratory Operations Plan*[17]. Note that other than possibly sealed sources, radioactive material will not be handled in the SWPF Laboratory until DOE grants approval to commence Hot Operations.

The Commissioning and Testing organization tested (CG&A, SOT, or ISOT) such facility-specific laboratory items as the laboratory HVAC, sampler operation, and gas and water supply systems. The Laboratory organization takes the lead in testing and certifying instrumentation for the SWPF Analytical Laboratory is ready for use.

3.6 Integrated Water Run Phase

The IWR Phase is the transition phase from water operation to chemical operations. The initial portion of IWRs consists of operating larger sections of the facility using water and preparing the facility for introduction of chemicals. Prior to introduction of chemicals during IWR, MSA-2 will conclude and the SWPF Project Manager will approve formal Plant turnover to Operations. The process for turning over jurisdictional control of SWPF from Commissioning and Testing to Plant Operations is detailed in PP-OP-8515, *Jurisdictional Turnover from Commissioning/Testing to Plant Operations*[2]. The process for system release is controlled per PP-OP-8524, *Operational Release*[2]. Systems will be operationally released.

The activities conducted with simulant prior to Cold Commissioning are:

- Systemization of the CSSX system to establish acceptable contactor hydraulic performance and operation of extraction, scrub, strip, and wash systems;

- Systemization and operation of the CCA;
- Systemization of the APAs; and
- Full-scale prototype mix testing in selected process vessels.

Procedures to be used during the IWR phase are overall guidance documents that direct unit operations and the use of the facility and plant operations procedures to the maximum extent possible.

3.7 Plant Performance Testing

Plant Performance Testing will be comprised of additional testing requested by Engineering and may occur at any point during the IWR phase, prior to or after the introduction of chemicals, or Cold Commissioning. The testing activities that will be performed during this time include:

- Operation of ASP;
- Operation of AFP;
- Validation of sparge mixing for long-term stabilization in the Sludge Solids Receipt Tank (SSRT)[A]; and
- Performance of other activities as specified by the Attributes or requested by Engineering.

The IWR and Plant Performance Testing test results, test deviations, and resolution of test deviations will be reviewed and approved by the CRB.

3.8 Cold Commissioning

Standard 5(f) Contract1 commitment:

> *Cold Commissioning: During the cold commissioning test period, the Contractor shall conduct all necessary testing operations to verify that the SWPF will perform in accordance with design specifications, using DOE approved non-radioactive simulant. The cold commissioning test periods will also be used to train SWPF staff. Prior to cold commissioning, the Contractor shall have in-place all necessary permits, licenses, and demonstrated that all interfaces are ready to support the cold commissioning.*
>
> *The Contractor shall carry out cold commissioning performance tests of the SWPF to meet the following objectives:*
>
> - *Verify that the SWPF can process a simulant material meeting the performance requirements for monosodium titanate (MST) concentration and filtration and Cs removal;*
> - *Demonstrate the design capacity for process systems;*

[A] The SSRT test requires input to this tank to be secured for a 30 day period. This test may be performed off site at the Parsons Technology Center in a prototype vessel.

- *Determine the operating characteristics of SWPF processes under routine and off-standard operating conditions including: demonstration of remote and hands-on maintenance activities; access to all equipment; ability to install, connect, disconnect, and reconnect replaceable components; and calibrations and/or functional testing of instruments; and*
- *Verify that the SWPF will meet environmental and permitting requirements that can be demonstrated using simulant.*

The cold commissioning tests, combined with other readiness activities, shall be planned and conceived to provide the operational and procedural basis necessary to support the hot operations request.

The Contractor shall provide a strategy to achieve the cold commissioning performance test objectives in the SWPF Commissioning Plan. Resultant non-radioactive products shall be disposed of as non-radioactive waste. Radioactive (spiked) products shall be transferred to the Site M&O Contractor in accordance with the Section C.9, Interface Control Requirements and disposed of as radioactive waste. The cold commissioning tests shall provide documentation showing that the products and secondary wastes meet the Waste Acceptance Criteria (WAC) of the receiving facilities, to the extent possible using simulant. If non-conforming product is produced, the Contractor is responsible for developing a course of action to be approved by the Commissioning Review Board.

(1) Testing Strategy: The Contractor shall provide a strategy to achieve the cold commissioning performance test objectives for commissioning the SWPF. Appropriate temporary analytical facilities may be used to perform elements of these demonstrations. During the tests, the Contractor shall provide documentation that the waste products and secondary wastes are in conformance with the receiving facilities WAC.

(i) <u>Process Verification Tests</u>: The Contractor shall complete SWPF process verification test (to the extent possible during Cold Commissioning using simulant) to demonstrate the waste processing functions (e.g., hydraulic capacity, cold chemical additions, air pulse agitator and filtration cycle performance) and non-radioactive Cs shall be utilized in these verification operations. Where needed, and determined beneficial, non-radioactive elements shall be used as a surrogate for radioactive elements. Test results will be evaluated and documented. (Table C.5-1.1, Deliverable 5.3B).

(ii) <u>Design Capacity Performance Tests</u>: The SWPF Functional Specification (P-SPC-J-00002) defines the design throughput capacity requirements for SWPF. During the cold commissioning tests, the following minimum testing shall be conducted to demonstrate the treatment capacity of the SWPF. This testing shall be conducted in accordance with the most recent version of V-RPT-J-00047. Revision 1 of V-RPT-J-00047 (dated August

4, 2015) will serve as the guiding document for this testing. Future changes to this document will require mutual agreement between DOE and the Contractor. This testing will be demonstrated as follows: Batches must meet the parameters defined in Table 1, Cold Commissioning KPP Summary Table of the Key Performance Parameter Verification Plan (V-PMP-J-00009) and as further defined through final development of the Commissioning Plan. These partial batches establish plant performance to demonstrate capabilities discussed in item (i) above.

- *Process 7 consecutive batches at a rate that demonstrates throughput greater than or equal to 7.3 Mgal/year.*
- *Batches must be processed through Alpha Strike Process and CSSX Process.*
- *DOE will approve the simulant composition via the Commissioning Plan prior to cold commissioning.*
- *The volume credited will be the volume of waste originally received in the Alpha Sorption Tank-A (adjusted to 6.44 M [Na]) associated with the batch of waste transferred out of the Decontaminated Salt Solution Hold Tank.*
- *All products and secondary wastes will meet the relevant specification and interface requirements. The results shall be provided to DOE for review and approval. (Table C.5-1.1, Deliverable 5.4).*

(iii) *Off-Standard Operational Testing: The Contractor shall conduct testing of the process and facility system to test and evaluate effects of off-standard operating conditions. The results shall be provided to DOE for review and comment (Table C.5-1.1, Deliverable 5.5). The operational tests shall be defined by the Contractor based upon anticipated equipment failures (e.g., contractor motor failure). Testing may be conducted on individual unit operations or plant systems. During the tests, the safety of the facility, operational personnel, the public, or the environment shall not be challenged.*

(iv) *Commissioning Results and Documentation: The Contractor shall provide all results from cold commissioning testing to DOE for review and approval. (Table C.5-1.1, Deliverable 5.7). The information shall be in the form of controlled copies maintained and updated by the Contractor. Information shall include, but not be limited to results of testing, test deviations and resolutions to test deviations.*

(v) *Test plans and outputs for process verification, product qualification.*

(vi) *Certification of Completion of Cold Commissioning: The Contractor shall certify to DOE that cold commissioning is complete and that the*

Contractor met the requirements contained in this section. (Table C.5-1.1, Deliverable 5.8, Milestone M5). This certification may be combined with the cold commissioning results. (Table C.5-1.1, Deliverable 5.7).

Cold Commissioning testing will be conducted using a salt solution simulant as the feed to the ASP and will use MST, solvent, and other process chemicals (Sodium Hydroxide [Caustic] [NaOH], HNO_3, etc.) that will be used during normal plant operations. Details associated with the composition of both the sludge and salt solution simulant are contained in Appendix B. DOE approval of the Commissioning Plan satisfies the Contract[1] requirement that states, "DOE will approve the simulant composition via the Commissioning Plan prior to cold commissioning."

The overall, primary objective of Cold Commissioning testing is to operate the plant systems at design flow rates, temperatures, and pressures using the simulant and actual process chemicals to verify that the plant is capable of meeting the Key Performance Parameters (KPPs) established in Table 1, *Cold Commissioning KPP Summary Table*, of V-PMP-J-00009, *SWPF Project Key Performance Parameter (KPP) Validation Plan*[18]. The KPPs and their required acceptance criteria are identified in Table 3-1, *KPP Acceptance Criteria*.

Table 3-1. KPP Acceptance Criteria

KPP	Parameter	Method (V-PMP-J-00009[18])	Acceptance Criteria
Meet SPF WAC/DSA	Sr (<2.87E+05 picocuries per milliliter [pCi/mL]), actinide (Class A) DSS limit	Analyze DSS to demonstrate cold Sr removed	With non-radioactive Sr; demonstrate Sr DF > 20 or Sr < detection limit in one mini-batch through normal sampling of AST-A and SSFT.
	Cs DSS limit (<5.06E+04 pCi/mL)	Analyze DSS to demonstrate Cold Cs removed	CSSX Performance: Non-radioactive Cs < detection limit or DF ≥40,000
	Isopar®L DSS limit (87.5 parts per million [ppm])	Analyze DSS for Isopar®L	CSSX Performance: DSS Isopar®L ≤ 87.5 ppm
Meet DWPF WAC for MST/Sludge	Concentrate solids in ASP/AFP (2-7 wt%)	Analyze MST/Sludge for Total Suspended Solids	Sludge Washing Performance: Solids concentration nominal 5wt%-7wt%
	Isopar®L limit (87.5 ppm)	Analyze MST/Sludge for Isopar®L	Sludge Washing Performance: Isopar®L ≤ 87 ppm
	Washing Effectiveness (Na < 0.7M)	Analyze MST/Sludge for Sodium	Washing Performance: Total Na concentration < 0.7M
Meet DWPF WAC for Strip Effluent	Concentrate Cs (Concentration Factor [CF]≥12)	Analyze strip effluent and CSS for Cs, Calculate CF	CSSX Performance: Non-radioactive Cs CF ≥12
	Isopar®L limit (<87.5 ppm)	Analyze strip effluent for Isopar®L	CSSX Performance: SE Isopar®L ≤87 ppm

Table 3-1. KPP Acceptance Criteria (cont.)

KPP	Parameter	Method (V-PMP-J-00009[18])	Acceptance Criteria
Mini-Batch Testing	Nominal flow rate demonstration (≥5.5 million gallons per year [Mgal/Yr])	21 mini-batch run	ASP Performance: Process 21 mini-batches of material at an equivalent throughput ≥ 5.5 Mgal/yr CSSX Performance: Process the equivalent of 21 mini-batches of material through CSSX at an equivalent throughput ≥ 5.5 Mgal/yr AFP Performance: Process 3 mini-batches of material at an equivalent throughput ≥ 5.5 Mgal/yr
	Peak flow rate demonstration	7 mini-batch run	ASP Performance: Process 7 mini-batches of material at an equivalent throughput ≥ 7.3 Mgal/yr CSSX Performance: Process the equivalent of 7 mini-batches of material through CSSX at an equivalent throughput ≥ 7.3 Mgal/yr AFP Performance: Process 1 mini-batches of material at an equivalent throughput ≥ 7.3 Mgal/yr
Peak Throughput Performance Testing	Peak Capacity demonstration (≥7.3 Mgal/yr rate)	7 batch run	Process through ASP and CSSX 7 consecutive full batches at an equivalent throughput of ≥ 7.3 Mgal/yr
Other Cold Commissioning Testing	Abnormal Operations	Demonstrate ability to recover from upset conditions	The objective is to demonstrate the SWPF system operability under varied conditions and parameters using non-radioactive waste simulants and process chemicals. Specific acceptance criteria are detailed in the associated Attributes.
	Environmental Performance Testing	Perform Environmental Testing as Needed to Meet Permit Requirements	Stack instrumentation tests will verify operability and reliability of instrumentation to measure flow velocity and temperature.

Much of the planned Cold Commissioning testing will be conducted by processing mini-batches of simulant through the unit processes while verifying system performance. This method will minimize simulant and chemical use while optimizing system and equipment operation, and provide maximum opportunity for operator training and qualification (T&Q). The mini-batch testing will be repeated as needed to get each system and unit process operating within required parameters and gain the operational experience needed to conduct the specific Cold Commissioning tests. The major categories of Cold Commissioning tests are: Process Verification, Design Capacity Performance, Off-Standard Operational, and Environmental

Performance. Test plans are in development for each of these major categories of testing. The plans will be reviewed and approved by the CRB.

Full-size batches will be used when required to perform the Design Capacity Performance Test (DCPT). During this test, simulant batches will be reconstituted after processing and reused to complete the testing. Other testing planned, during DCPT, will include simulated product transfer tests to DWPF and Tank 50, and laboratory testing to validate methodologies and turn-around times, and to ensure quality requirements are met (analytical and cold chemicals).

Test procedure guidance documents will be prepared for execution of the major categories of Cold Commissioning testing conducted per approved test plans. As discussed above, simulant composition and reconstitution requirements are defined in Appendix B. This appendix also contains information for such feeds as MST, caustic dilution, strip, scrub, and wash solutions.

In addition, test procedures will be prepared by qualified Test Engineers and approved by the CRB prior to use and, to the maximum extent possible, will invoke plant operating and administrative procedures for testing, operational, and maintenance activities. This will provide the opportunity to evaluate the effectiveness of the plant operating and maintenance procedures, and provide OJT for O&M personnel.

Any deficiencies identified during Cold Commissioning testing will be resolved or accepted, in accordance with relevant procedures listed in Table 1-1. During this testing phase, repairs or modifications will be undertaken by O&M personnel supported by Commissioning and Testing personnel. Attributes will be closed and have final sign-offs with the exception of acceptance criteria designated for completion during Hot Commissioning.

3.8.1 Process Verification Tests

As required by the Contract[1], the EPC will complete Process Verification Tests (PVTs), to the extent possible during Cold Commissioning, using simulant to demonstrate the waste processing functions. Test results will be evaluated and documented (Contract Deliverable 5.3B[1]).

PVT requirements will be included in a test plan that will be approved by the CRB. The plan will include test requirements for each of the unit operations (ASP, CSSX, and AFP).

PVTs will be conducted primarily using reduced batch sizes, called mini-batches, with the bulk of PVT performed prior to the DCPT seven-batch run discussed below. At least 28 mini-batches will be processed through SWPF during Cold Commissioning. Processing will normally be through two of the unit operations (ASP and CSSX). In addition to confirming SWPF performance, mini-batches will be used to provide operator training and evaluate equipment operability and performance. This will include evaluation of SWPF throughput capacity.

Mini-batch runs involve operating the facility using reduced batch sizes in the ASP and AFP and operating CSSX in a batch mode. Filter cleaning and other support operations will be completed as needed to support proficiency and plant operation. The simulant will be spiked with non-radioactive Cs as needed to confirm Cs removal performance. The plant equipment and operating procedures will be adjusted as required to enable operation at nominal and peak flow rates.

Waste simulant with non-radioactive Sr and Cs spikes will be introduced into the ASP for processing. During the adsorption and filtration cycles, concentrated MST/sludge will collect in the Filter Feed Tank-A and CSS will collect in the Salt Solution Feed Tank (SSFT). The MST/sludge batch will be transferred to the SSRT, where it will be washed, sampled, and analyzed to verify compliance with the MST/sludge solids composition, Na, and Isopar®L concentration acceptance criteria for MST/sludge product. The SSFT contents will be sampled and analyzed for Cs and Sr concentration. The Sr concentration will be used to calculate the equivalent ASP DF value for Sr. The Cs concentration will be used in later calculations to determine the CSSX Cs CF.

The CSSX process will be operated and the DSS and SE will be sampled and analyzed to assess the process ability to produce products meeting the DSS and SE product KPPs. Samples will be taken and analyzed to demonstrate Sr and Cs removal, and Isopar®L concentration acceptance criteria for DSS product. Samples of SE will be taken and analyzed to determine SE Cs and Isopar®L concentrations. The SE Cs concentration, combined with the CSS Cs concentration previously determined, will be used to calculate the CSSX CF and subsequently determine the overall efficiency for the extraction contactor bank, to the extent allowed using a non-radioactive simulant.

3.8.2 Design Capacity Performance Tests

The DCPT is a single sustained run of SWPF operation utilizing seven consecutive full batches of feed. This will validate the peak performance of the SWPF on a sustained basis.

As discussed above, mini-batch runs in support of PVT and proficiency will be conducted during Cold Commissioning. It is expected the DCPT would be preceded by mini-batch runs to ensure the SWPF operating characteristics are well understood before executing the DCPT. Mini-batch runs would resume following the DCPT to support proficiency and any outstanding PVT requirements. Full batch and/or mini-batch runs will be used to support readiness review activities as needed including the management self assessment, the CORR and the DOE ORR. The primary overall DCPT test objective is to demonstrate continuous operation of the integrated plant processes for at least seven consecutive full batches above the Minimum Required Peak Throughput. The volume credited will be the volume of waste originally received in AST-A corresponding to the batch of DSS transferred out of the DSS Hold Tank (DSSHT). Production of a corresponding volume of SE in the Strip Effluent Hold Tank (SEHT) ready for transfer to DWPF, and MST/sludge ready for washing in the SSRT is also required to obtain credit for processing each batch. All analytical analyses supporting the production rate are to be demonstrated. The specific acceptance criteria are detailed in Table 3-2, *Cold Commissioning DCPT Matrix and*

Acceptance Criteria. Additional details associated with plans for the DCPT are included in V-RPT-J-00047, *SWPF Project Design Capacity Performance Test Whitepaper*[19].

Table 3-2. Cold Commissioning DCPT Matrix and Acceptance Criteria

Test	Purpose	Performance Test Acceptance Criteria*
Alpha Strike Performance	Demonstrate satisfactory MST performance.	• Alpha Strike throughput ≥ 7.3 Mgal/yr • AST-A (TK-101) filtered sample Sr < detection limit or Sr DF ≥ 20
Alpha Strike Cross-flow Filter (CFF) Performance	Demonstrate seven (7) sequential CFF concentration cycles.	• Filtration throughput ≥ 7.3 Mgal/yr • SSFT (TK-109) TIS < 100 Nephelometric Turbidity Unit (NTU) by process in-line turbidity instrumentation and confirmation <15 mg/L TIS by laboratory analysis
CSSX Performance	Demonstrate Cs mass transfer performance and CSSX solvent recovery at ≥ 7.3 Mgal/yr SWPF throughput equivalent.	DSS • CSSX throughput equivalent ≥ 7.3 Mgal/yr • Non-radioactive Cs < detection limit or DF ≥ 40,000 • DSS Isopar®L ≤ 87.5 ppm SE • Non-radioactive Cs CF ≥ 12 • SE Isopar®L ≤ 87 ppm
Design Capacity Throughput in Single Strike	Demonstrate parallel operation of Alpha Strike, Filtration and CSSX.	• SWPF throughput ≥ 7.3 Mgal/yr
Sludge Washing Performance	Demonstrate a nominal 5 wt% sludge batch washing and mixing in SSRT (TK-104).	• Solids concentration nominal 6 wt% • Na concentration < 0.7M • Isopar®L ≤ 87 ppm

Notes:
* Normal process samples will be outlined in the DCPT Plan.
** Key samples will be verified through independent laboratory analysis.

3.8.3 Off-Standard Operational Testing

Additional Cold Commissioning tests will be performed to demonstrate the performance limits for critical SWPF process equipment and systems under a range of off-normal conditions. At a minimum, this will encompass:

- Loss of Electrical Power;
- Loss of Ventilation;
- Loss of Plant Air;

- Loss of the BPCS; and
- Failed Contactor.

3.8.4 Environmental Performance Testing

Per the Contract[1], "The Contractor shall perform environmental testing as required under the Air Permitting Requirements, and applicable Federal, State, and local laws, regulations, and permits to demonstrate the operation of the SWPF in accordance with the regulatory requirements. The results of the testing shall be reported in accordance with permitting and regulatory requirements."

To meet this Contract[1] requirement, the SWPF stack instrumentation will be calibrated and tested in accordance with the regulatory requirements established in 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants*, Subpart H, *National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities*[20], during Cold Commissioning. Stack instrumentation tests will verify operability and reliability of instrumentation to measure flow velocity and temperature. The results of the testing will be documented and reported per regulatory requirements.

No other environmental performance testing is required during Cold Commissioning under the Air Permitting Requirements and applicable federal, state, and local laws, regulations, and permits to demonstrate the operation of the SWPF in accordance with the regulatory requirements. See Section 17.1.4 for environmental performance testing requirements during Hot Commissioning.

3.8.5 Cold Commissioning Test Results and Documentation

Cold Commissioning test results, test deviations, and resolution of test deviations will be reviewed and approved by the CRB. Cold Commissioning test results will be provided to DOE for review and approval to meet Contract Deliverable 5.7[1] requirements. A Cold Commissioning Process Verification report will be prepared by Operations, approved by the CRB, and submitted to DOE for information purposes to meet Contract Deliverable 5.3B[1] requirements. This report will document the results of the product verification testing designed to show that the facility is capable of meeting product specifications defined in the WAC for DWPF and HTF Tank 50. The DCPT results will be provided to DOE for final approval and to meet Contract Deliverable 5.4[1] requirements. Off-standard operational test results will be provided to DOE for review and comment and to meet Contract Deliverable 5.5[1] requirements.

A certification that Cold Commissioning has been completed and that Cold Commissioning Contract[1] test requirements have been met will be submitted to DOE for approval. This certification meets Contract Deliverable 5.8[1] requirements.

4.0 SWPF MAINTENANCE PROGRAM

S-RCP-J-00001, *SWPF Standards/Requirements Identification Document*[21], mandates that the SWPF Maintenance Program conform to the requirements set out in DOE O 433.1B,

Maintenance Management Program for DOE Nuclear Facilities[22] (the Order). Per the Order[22], SWPF will develop and implement a Nuclear Maintenance Management Program (NMMP). PL-MN-8704, *SWPF Nuclear Maintenance Management Program Plan*[23], presents the current and planned development of the NMMP and V-PMP-J-00062, *Nuclear Maintenance Management Program Description Document*[24]. The NMMP consists of a series of implementing plans and administrative procedures that address the requirements of the Order[22] and S-RCP-J-00001[21].

The NMMP also incorporates the awareness that integration with complimentary programs is required. Examples of complimentary programs include Conduct of Operations, Radiation Protection, QA, ISMS, and Configuration Management (CM).

The plans and procedures that comprise the NMMP describe how maintenance is analyzed, administered, and performed on SSCs, including those that are part of the safety basis.

Maintenance Technicians will have the requisite skill set of their particular discipline. They will receive facility-specific training and any specialized task training through classroom instruction and OJT. At the end of this instruction, the Maintenance Technicians will be assessed and qualified to perform maintenance tasks.

The SWPF Maintenance organization is provided with a number of workshop facilities equipped with the necessary repair tools and equipment to efficiently support the facility maintenance and maintenance training functions. There are four types of workshops in uncontrolled or "clean areas" where maintenance on uncontaminated equipment will be performed: mechanical, electrical, instrument, and general maintenance. In addition, there are two controlled area workshops where maintenance work can be performed on equipment that has been in contact with the process.

Based on the complexity of SWPF equipment, a multitude of failure modes are possible. Each of these failures will affect the SSCs and operating processes in some way, but in each case the consequences vary. These consequences most strongly influence the extent to which an attempt is made to prevent a failure. Measures are taken to prevent failure that has significant consequences from affecting an SSC that is important to safety or production. The main reason for doing any form of proactive maintenance (i.e., predictive, preventive, or troubleshooting) is to avoid, reduce, or eliminate failure.

Four types of maintenance will be practiced at SWPF:

- <u>Predictive (or condition-based) tasks</u>: Actions taken to monitor and analyze trends, parameters, or properties to discern whether an SSC may be deteriorating;
- <u>Preventive Maintenance</u>: Planned, systematic, or periodic maintenance actions to prevent SSC failure and extend operating life;
- <u>Corrective Maintenance</u>: Repair of failed or malfunctioning equipment to its intended function or design condition; and

- Troubleshooting: Tasks to discover hidden failures through detection of degradation of the function.

An effective system for planning maintenance work will be utilized in accordance with DOE O 433.1B[22]. The process will include planned maintenance work orders generated by the Computerized Maintenance Management System (CMMS) or corrective maintenance initiated from a service request. SWPF personnel may initiate a service request. Service requests will be screened and, if approved, the work activity will be planned including developing a JHA and obtaining any required permits and necessary spares.

As part of the development of the maintenance program there is an activity in the commissioning schedule reserved for maintenance trials. Within a one-of-a-kind nuclear processing facility, there are items of equipment that require maintenance, and for a number of different reasons that maintenance may present a significant challenge. To assess the extent of those challenges, maintenance trials will be conducted as outlined in PL-MN-8701, *SWPF Maintenance Trial Test Plan*[25], prior to Cold Commissioning to confirm that maintenance can be carried out successfully. In addition, the maintenance trials will validate the maintenance instruction and provide training for maintenance technicians. The majority of maintenance trials are planned to be performed during startup testing. A selection of the maintenance trials performed prior to Cold Commissioning will be performed during Cold Commissioning under mock radiological conditions to provide additional training for the Maintenance Technicians and to further refine the applicable maintenance instructions.

5.0 SWPF TRAINING AND QUALIFICATION PROGRAM

SWPF training and training organization details are included in PL-TR-1801, *SWPF Personnel Selection, Training, and Qualification Plan*[26].

The SWPF training program applies a graded approach to the Systematic Approach to Training (SAT) model described in DOE-HDBK-1078-94, *DOE Handbook Training Program Handbook: A Systematic Approach to Training*[27], and in DOE-HDBK-1074-95, *Alternative Systematic Approaches to Training*[28], to implement DOE O 426.2 Chg. 1, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*[29], and other contractual requirements. SAT is an approach to training that is based on tasks and the related knowledge and skills required for competent job performance. T&Q Specialists, line and program management, and SMEs collaborate to:

- Identify training requirements for specific job positions through the use of needs analysis and job analysis prior to each phase of testing and commissioning;
- Use information from analyses to select training settings, prepare training program descriptions, and write specific learning objectives and evaluation methods that guide the development of training materials and strategies;
- Use training program descriptions, objectives, learning objectives, and evaluation methods to select appropriate instructional methods and develop training materials;

- Allocate resources, plan and schedule, and conduct and document training; and
- Evaluate the effectiveness of the aforementioned analysis, design, development, and implementation activities.

The SWPF Project Training Implementation Matrix (TIM) tracks the requirements of DOE O 426.2 Chg.1[29] as they relate to the SWPF and describes how the requirements are implemented. The TIM will be submitted to DOE for review and approval and fully implemented prior to the CORR.

Test Engineers are qualified under ASME NQA-1-2004, Appendix 2A-1[12]. The T&Q programs for personnel who perform SWPF testing and commissioning activities are described in training documents listed in Table 1-1.

Each training program description document:

- Defines management and team roles, responsibilities, authorities, and accountabilities;
- Describes methods of instruction, evaluation, failure policies, entry-level requirements, initial and continuing training, and requalification requirements; and
- Delineates curriculum for each position.

Qualification standards and qualification cards are developed for applicable positions. The assigned training and the qualification status of each employee is tracked and reported to SWPF management by the Training organization.

Position-specific education, training, and experience requirements are specified on Form SWPF-098, *SWPF Parsons Project Position Description (PPD)*, in accordance with PP-TM-1402, *New Hire and On/Off Boarding*[2], and are communicated to the employee via the process described in PP-TR-1802, *Employee Indoctrination and Training*[2]. The Project Position Description section of Form SWPF-098 identifies the following for each position:

- Minimum education, experience and training requirements;
- Specialized qualifications/certifications (if applicable to the position);
- Specific knowledge, skills, and abilities; and
- Roles and responsibilities.

In accordance with ISMS principles, personnel are confirmed as having Competence Commensurate with Responsibility (CCR) prior to being assigned to work independently on the Project. This is ensured via a combination of PPD screening of personnel education and experience, initial Project training and indoctrination of personnel, and completion of job/position-specific qualification programs, as applicable.

The training program will continue to mature as the Project progresses toward Hot Operations and it is expected the documents discussed in this section may change as a result.

6.0 SWPF CONDUCT OF OPERATIONS PROGRAM

S-RCP-J-00001[21] mandates that the SWPF Operations conform to the requirements set out in DOE O 422.1, *Conduct of Operations Requirements for DOE Facilities*[30] (the Order). The scope of this section is to address the requirements of the Order[30].

DOE O 422.1[30] includes 18 areas of Operations that are addressed by PL-OP-8503, *SWPF Conduct of Operations Implementation Plan*[31]. Implementing procedures for DOE O 422.1[30] were developed as P-CMP-J-00001, *SWPF Conduct of Operations Manual*[32], which comprises the procedures that implement the 18 areas addressed in the Order.

Operations activities and the safety of workers at SWPF will be managed under the Conduct of Operations program. This program will ensure formality of operations in activities and be applied equally to employees and sub-contractors. Prior to entry into Cold Commissioning, all Conduct of Operations procedures will be approved and all personnel will be trained in Conduct of Operations procedures and principles.

The facility will be in full compliance with DOE O 422.1[30] prior to start of Cold Commissioning. Full implementation of CONOPS is defined as completion of PCAR-CO-002.

6.1 Procedure Management

The procedure management program is a vital portion of SWPF Conduct of Operations Program used to support disciplined operations and to implement other Safety Management Programs. The procedure management program requirements are implemented through P-CMP-J-00001[32] procedures, PP-CONOPS-17.1, *Procedure Administration*[32]; and PP-CONOPS-17.2, *Procedure Compliance*[32]. In addition, administrative procedures and plans are reviewed and approved in accordance with PP-DC-3012, *Document/Administrative Procedure Preparation and Review*[2], while the SOT, ISOT, IWR, and Cold Commissioning test procedures used by Commissioning and Testing are managed and controlled under PP-CM-8102, *Startup Test Procedure Administration*[2].

Operations personnel receive training on Procedure Management principles during the classroom phase of the qualification program prior to reporting to the facility. These principles are used to develop operations procedures that support facility operations and testing, which included SOTs and ISOTs. The procedures are reviewed by Commissioning and Testing personnel, CSEs, Nuclear Safety, and associated Safety and Support personnel to ensure they support the implementation of required Safety Management Programs. Following testing, these procedures will be reviewed, validated, and approved for use as Standard Operating Procedures (SOPs) to support Cold Commissioning activities.

As the DSA/Technical Safety Requirements (TSRs) are finalized and approved, Operations personnel will develop the procedures needed to support DSA/TSR requirements. These procedures will include Abnormal Operating Procedures (AOPs) and Emergency Operating Procedures (EOPs) described in the DSA/TSRs, surveillance procedures necessary to ensure

operability of Safety Significant (SS) SSCs, and administrative procedures necessary to implement other Safety Management Programs.

SWPF procedures are available via the Policies, Plans, and Procedures page on Salt Project Collaboration Portal (https://swpf.parsons.com/sites/salt/ppp/default.aspx).

7.0 SWPF ENVIRONMENTAL, SAFETY AND HEALTH PROGRAM

The SWPF utilizes an ISMS to ensure the systematic and effective implementation of ESH requirements, including Environmental Protection, Industrial Safety, IH, and Occupational Safety, into aspects of the SWPF Project. The SWPF Project's management system comprises the universe of policies, plans and procedures that define responsibilities and methods for conducting Project work. Q-PLN-J-0100, *SWPF Environmental Management Systems Program Description*[33], and P-EIP-J-00001, *SWPF Integrated Safety Management System Description*[34], describe specific subsets of the Project's overall management system and processes in an integrated approach that is appropriately tailored to the risks or work activities being performed. These documents are reviewed annually and updated as necessary to reflect changes and transition through Project phases.

During Commissioning, ESH will maintain S-EIP-J-00001, *Environmental Plan*[35], and other required environmental documents. Environmental support for Commissioning activities includes monitoring environmental systems and processes and conducting air emissions calculations to support regulatory reporting. Environmental oversight activities include the following:

- Ensuring compliance with the:
  - SWPF Industrial Wastewater Construction Permit;
  - Sewer and Domestic Water Permits, including discharge to the sewer of condensate water/cooling tower blowdown;
  - Spill Prevention Control Countermeasures Plan; and
  - Industrial Activity Stormwater Permit;
- Updating the Environmental Plan as necessary;
- Submitting hazardous waste and community right-to-know reports; and
- Developing environmental procedures, and providing oversight of other required permits.

Pursuant to the Department of Health and Environmental Control (DHEC) Wastewater Construction Permit for the SRS/Salt Waste Processing Facility/Phase 2, Permit 19219-IW, the EPC is required to submit final as-built drawings that will include the list of leak test reports and Professional Engineer-stamped process flow configuration drawings. These documents will be submitted per the Project schedule to obtain South Carolina Department of Health and Environmental Control (SCDHEC) approval to place the SWPF into operation and connect to the waste transfer lines.

The Industrial Safety, IH and Occupational Safety program scope includes supporting general ESH tasks and providing hazards analysis and review for operational activities. Specific safety activities include:

- Behavior Based Safety Program;
- ISMS program oversight;
- Shift coverage and field oversight and assessments of work planning and execution;
- Monitoring of such facility conditions as noise, air quality, chemical exposures; and
- Development and implementation of PM-OP-8501, *SWPF Operations Safety Manual*[36], and related health and safety procedures.

The key ESH plans are listed in Table 1-1. Additionally, during Commissioning and Operations, ESH will support ongoing industrial and chemical safety reviews, maintain a Spill Prevention Control Countermeasures Plan, implement 10 CFR 851, *Worker Safety and Health Program*[37], and assess implementation for compliance with requirements.

8.0 SWPF EMERGENCY PREPAREDNESS PROGRAM

PP-OP-8509, *J-Area Emergency Response*[2], provides procedures to be used in response to emergency events, including medical, fire/explosion, spills and releases, and malevolent acts. This procedure supports current construction and operations activities, and will be replaced by AOPs and EOPs during Cold Commissioning.

DOE has contracts in place with Site Management and Operating (M&O) for emergency services. The SWPF emergency plan for Hot Commissioning and Operations is contained in Annex K to SCD-7, *Savannah River Site Emergency Plan*[38], which outlines the activities to be performed by SWPF personnel in the facility and by the Emergency Response Organization (ERO) in the Emergency Operations Center (EOC). The SRS Emergency Plan defines appropriate response measures for the managing of emergencies. The SRS Emergency Plan forms the policy basis for the conduct of operations related to emergency planning, response and consequence mitigation. SRS will provide emergency response services in the form of fire, hazmat, medical, security, and law enforcement. Site M&O also provides site emergency communications systems and is responsible for the notification to offsite agencies regarding declared emergencies and other required offsite notifications. Additionally, the emergency services contract includes provisions for the use of the mutual aid agreements and letters of agreement that Site M&O has in place to provide mutual assistance to the site by local fire departments, ambulance service, police departments and hospital facilities.

8.1 Hazard Surveys and Emergency Planning Hazards Assessments

Hazards surveys were developed for SWPF to determine inventories of hazardous materials that will exceed the screening thresholds during Hot Commissioning and once the plant starts normal operations. Materials that exceed the screening thresholds were analyzed in the Emergency Planning Hazards Assessment, which analyzed the hazards through a compilation and screening

of both radiological/non-radiological inventories with respect to their airborne hazard potentials and personnel exposure capabilities. From the identified scenarios, a consequence assessment was performed that determines dose/concentrations at defined receptor locations. The analysis is also required to address malevolent acts. This analysis determined whether any credible releases of these materials could increase the risk to site workers or to the general public.

As a result of these assessments, Emergency Action Levels (EALs) were identified for the major hazards present at SWPF. The EALs identify the emergency classification level for a hazardous material/radiological release. The declaration of an Alert or higher emergency classification results in the activation of the Site EOC.

The EALs are incorporated into Emergency Program Implementing Procedures to be used by the Area Emergency Coordinator for SWPF-based classifiable emergencies. The EALs will also be provided to the SRS Operations Center as part of Annex K to SCD-7 for training and incorporation into their classification and response procedures.

8.2 Emergency Response Training, Walkthrough and Drills

Training will be conducted for SWPF personnel, and walkthroughs will be provided for Site emergency responders to the Technical Support Room. To reinforce classroom training, walkthrough of potential emergency scenarios will be conducted with full participation by involved parties, including Site support organizations as available. Once walkthroughs are satisfactory, exercises will be conducted and critiqued to evaluate the performance of involved personnel. Critique feedback will be considered and may be incorporated into applicable procedures.

A final exercise will evaluate SWPF personnel's ability to respond to SWPF emergencies. This exercise may be part of the Site's normal annual exercise. It will be observed by one or more DOE ORR team members or designees. This exercise will evaluate the level of readiness of the SWPF personnel and a portion of the Site ERO.

Upon a successful demonstration, any issues that are raised will be reviewed for incorporation into Annex K of the Site Emergency Plan (SCD-7[38]) and the implementing procedures.

9.0 SAFETY BASIS APPROVAL AND IMPLEMENTATION

Prior to commencing the CORR and DOE ORR, safety basis documentation must be in place and implemented. This documentation describes the "safety envelope" of the facility by identifying the hazards, characterizing the hazards/risks, and identifying the controls to prevent or mitigate the hazards and keep the worker and public safe. The implementation of the facility safety basis involves the following major activities:

- **Safety Basis Development**. A DSA and TSR was developed, reviewed by the SWPF Facility Operations Safety Committee (FOSC) and EPC Project Management and submitted for DOE review and approval. The equipment that needs to be operational and the administrative programs relied upon for nuclear safety are defined in these documents. At this time, the

SWPF DSA and TSR will incorporate the results of hazard analyses for the interface between SWPF and existing SRS Liquid Waste facilities as described in S-CHA-S-00001, *Consolidated Hazards Analysis for the Defense Waste Processing Facility Integrated With the Salt Waste Processing Facility*[39], and successor documents developed by the LWO.

- **Unreviewed Safety Question (USQ) Determination Process.** PP-NS-5507, *SWPF Unreviewed Safety Questions*[2], was submitted to and approved by DOE. Personnel have been trained in the USQ process.

- **DOE Review Comments and Disposition.** Following receipt of DOE comments on the SWPF DSA and TSRs, Nuclear Safety personnel will interface as necessary with Operations, Engineering, and other affected organizations/disciplines and disposition each comment. As necessary, DOE will be consulted to aid in timely resolution. Once completed, the dispositioned comments will be submitted to DOE for review and approval.

- **DOE Approval of the Safety Basis Submittals**. DOE will prepare and issue a Safety Evaluation Report (SER) to document their approval of the documents and any conditions of approval.

Following DOE approval, O&M procedures will be revised as necessary to address related dispositions to the DOE comments. USQ documentation (typically a USQ screen) will be prepared as necessary for procedures to ensure the procedures properly reflect the requisite safety basis requirements.

9.1 Phased Approach to Safety Basis Implementation

The detailed sequence of implementation activities is documented in the SBIP[7]. The SBIP identifies major activities that must be completed as part of the implementation process. The SWPF Safety Basis Documents (i.e., DSA and TSRs) were developed and reviewed in accordance with PP-NS-5504, *Development and Control of the Documented Safety Analysis and Technical Safety Requirements*[2]. The SBIP consists of four phases:

- Phase I was completed when DOE formal review began (with Revision C issuance of the DSA/TSRs).

- Phase II of the SBIP follows Phase I and ends when DOE issues the SER approving the Safety Basis for SWPF. The USQ Process will commence, reviewing proposed activities, but the USQ documentation will not be signed.

- Phase III of the SBIP starts with the issuance of the SER, and ends when SWPF declares that the Safety Basis is Pre-Authorization to Operate (ATO) implemented. The USQ documentation for proposed activities will be completed prior to the end of Phase III.

- Phase IV of the SBIP starts with the declaration that the Safety Basis is Pre-ATO implemented, and ends at the end of Hot Commissioning. The USQ documentation for proposed activities will be completed in accordance with the SBIP during Phase IV.

10.0 SWPF QUALITY ASSURANCE PROGRAM

To support the commissioning of the SWPF, V-QP-J-00001, *SWPF Quality Assurance Plan*[40], and applicable implementing procedures provide the controls required to ensure that QA personnel are involved in the determination of acceptance and test criteria and the verification of test protocols.

During Commissioning and Operations, the QA/QC program staff will conduct inspections/oversight for receipt of materials, testing, instrumentation and calibrations. QC will provide shift support and inspections for maintenance, operations, systemization, ORRs, and start-up activities. QA is also responsible for acceptance of subcontracted work on a graded approach.

Tests required for the collection of data to verify conformance of an item to specified requirements or to demonstrate satisfactory performance for service shall be planned and executed. Characteristics to be tested and test methods to be employed shall be specified in accordance with approved procedures. Test results shall be documented and their conformance with test requirements and acceptance criteria shall be evaluated.

Test requirements and acceptance criteria shall be provided or approved by the responsible organization. Required tests shall be controlled under appropriate conditions using the tools and equipment necessary to conduct the test in a manner to fulfill test requirements and acceptance criteria. The tests performed shall obtain the necessary data with sufficient accuracy for evaluation and acceptance.

Test requirements and acceptance criteria shall be based upon specified requirements contained in applicable design documents, or other pertinent technical documents that provide approved requirements.

11.0 SWPF FIRE PROTECTION PROGRAM

NOTE: There was a Code of Record change from DOE O 420.1B, *Facility Safety*[41], to DOE O 420.1C Chg.1, *Facility Safety*[42], in order to accommodate that design change activities are performed per DOE O 420.1B[41]. Such non-design activities as those listed below are performed per DOE O 420.1C Chg.1[42].

A Project Fire Hazards Analysis has been developed for the facility in accordance with DOE O 420.1B[41]. This is documented in F-FHA-J-00001, *SWPF Project Fire Hazards Analysis*[43]. F-PP-J-00001, *SWPF Fire Protection Program Plan*[44], describes responsibilities for implementation of the Fire Protection Program. The scope of the Fire Protection Program Plan includes:

- Controlling ignition sources and transient combustible loading;
- Controlling impairments of fire protection components and systems;
- Controlling work activities to ensure fire protection concerns are properly addressed;

- Establishing compensatory measures to mitigate the consequences of system impairments;
- Responding to area fires;
- Performing surveillance testing;
- Training personnel; and
- Performing assessments for compliance to established requirements.

The program is intended to include oversight by Fire Protection personnel throughout the process to ensure the entire program meets the requirements of DOE O 420.1C Chg.1[42]. Self-assessments will be conducted and documents updated by Fire Protection personnel throughout the life of the facility.

The Plan includes configuration control, control of physical work (including hot work), administrative controls, fire control features and control of combustibles, training, fire emergency preparedness, and ongoing documentation of the program.

Interfaces of SWPF programs and SRS programs are documented and records maintained.

System testing and acceptance will be conducted in accordance with National Fire Protection Association codes and DOE requirements.

12.0 SWPF WASTE MANAGEMENT PROGRAM

To implement fully successful waste management programs, waste minimization and pollution prevention provides the bases for waste management at SWPF. Where these SWPF programs interface with their corresponding SRS programs, the roles and responsibilities of the various parties are defined within the relevant Interface Control Documents (ICDs).

12.1 Waste Minimization and Pollution Prevention

Waste minimization and pollution prevention begins with design and ends with employee awareness and participation.

Waste minimization and pollution prevention is an extension of the design concepts that are integral to the SWPF design process (e.g., systems engineering, As Low As Reasonably Achievable [ALARA]) and good engineering practice. This systematic program will allow SWPF to demonstrate compliance with regulatory requirements, and to take credit for ongoing pollution prevention activities. The goals of waste minimization and pollution prevention are to achieve sustainable economic development as well as to minimize raw material consumption, energy consumption, waste generation, health and safety impacts, and ecological degradation over the entire life of the facility. A cost-effective and sound, multi-media, prevention-based approach to environmental protection is a major key to achieving environmentally sustainable economic development. A multi-media, waste minimization and pollution prevention approach would reduce waste generation and the emission of pollutants released to land, air, and water without transferring pollutants from one medium to another.

The activities required to implement a comprehensive program include:

- Establishing approved waste disposition paths;
- Determining acceptable and achievable goals;
- Establishing management commitment to waste minimization and pollution prevention goals;
- Performing waste assessments;
- Characterizing waste streams and resource consumption;
- Identifying opportunities to eliminate, reduce, reuse, or recycle;
- Assessing feasibility and cost benefits of opportunities;
- Implementing selected opportunities;
- Incorporating into work control process;
- Documenting and evaluating waste minimization progress; and
- Training each employee to understand the SWPF commitment to waste minimization and pollution prevention.

12.2 Waste Categorization

The SWPF developed V-WCP-J-00003, *SWPF Waste Certification Plan*[45], which demonstrates the waste from SWPF meets the WAC for waste types generated. It describes the methods for identifying, segregating, characterizing, packaging, and handling newly generated Low Level Waste (LLW), Hazardous Waste (HW), Mixed Waste (MW), and Transuranic Waste (TRU). It provides assurance that waste transferred to a disposal facility meets the receiving Treatment, Storage, and Disposal Facilities requirements. V-WCP-J-00003[45] defines SWPF waste in the following five categories:

- LLW - Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, TRU waste, byproduct material (as defined in Section 1 IIe.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material (Adapted from: Nuclear Waste Policy Act of 1982, as amended).

- HW - Waste that is a hazardous component subject to the Resource Conservation and Recovery Act (Adapted from: Federal Facility Compliance Act of 1992).

- MW - Waste that contains both radioactive and hazardous components as defined by source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954, as amended, and a hazardous component subject to the Resource Conservation and Recovery Act (Adapted from: Federal Facility Compliance Act of 1992) respectively.

- TRU - Radioactive waste containing more than 100 nanocuries (3,700 Becquerel) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years, except for:

(1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*[46] disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61, *Licensing requirements for land disposal of radioactive waste*[47].

- Radioactive Liquid Waste (RLW) - Similar to TRU waste, RLW that does not meet the criteria for LLW should not be generated. Prior to removing a component from the system, a study should be conducted on the methods required to eliminate the generation of this waste stream. A spray down system with water and HNO_3 is available to decontaminate items prior to removal.

The SWPF will generate Radioactive Solid Waste (RSW) throughout the life of the facility, beginning with the start of Hot Commissioning. Failed equipment (pumps and valves), expended Alpha Strike filters, high-efficiency particulate air (HEPA) filters, and job control equipment (decontamination supplies, wipes, and disposable protective equipment) will be the largest sources of RSW.

RSW generated in the SWPF Process Building will consist of LLW, TRU Waste, and MW, and shall be packaged in U.S. Department of Transportation (DOT)-approved containers. A waste inventory of contents shall be maintained for each LLW container. The EPC shall be responsible for obtaining radiation survey/assay data of the container or for obtaining samples and analysis of the container contents, in order to characterize the waste. Filled waste containers shall be staged in a waste staging radioactive materials area inside the SWPF, in accordance with DOE O 435.1, *Radioactive Waste Management*[48], staging requirements until it can be transported to the Treatment, Storage, or Disposal facility.

HW/MW generated in the SWPF Process Building shall be packaged in DOT-approved containers or other specially approved containers for truck shipment to a Treatment, Storage, or Disposal facility. A waste inventory of contents shall be maintained for each HW/MW container. The EPC shall be responsible for obtaining radiation survey/assay data of the container or for obtaining samples and analysis of the container contents in order to classify the waste. Filled HW/MW containers shall be staged in a waste staging area inside the facility until they can be transported for treatment and disposal.

13.0 SWPF RADIATION PROTECTION PROGRAM

13.1 Initial Commissioning Phase

During the design and construction phases of the SWPF, Engineering and Construction have been supported by a Radiation Protection Program Manager (RPPM) (Certified Health Physicist). The RPPM ensured that design features were incorporated for operations that would minimize personnel exposure levels, control potential sources of contamination and airborne radioactivity at the point of origin, and develop means to ensure waste minimization. In Calendar

Year 2006, SWPF submitted S-CIP-J-00004, *Radiation Protection Program for 10 CFR 835 (Occupational Radiation Protection)*[49], which was approved by DOE with subsequent revisions accordingly approved (Rev. 5 approved in February 2017: SWPF-17-071). The principal intent and/or purpose of the SWPF Radiation Protection Program (RPP) was to commit to the applicable subparts of 10 CFR 835, *Occupational Radiation Protection*[50], respective of the design, control, management, procedures and records related to the design of a new DOE facility.

During the final phases of construction, the RPPM continued to support Engineering and Construction in the verification of design elements and installation of radiological instrumentation.

13.2 Cold Commissioning

The SWPF will be placed in various "mock-up" radiological configurations during Cold Commissioning, with access and controls simulating full-scale radiological operations. (There will be provisions for certain activities to be allowed which may provisionally be exempted from the mock-up radiological controls if unnecessary hazards would be introduced.)

Implementing the mock-up of radiological controls during Cold Commissioning will afford SWPF Management and Radiation Protection the opportunity to observe, evaluate, and enhance the implementation of radiological controls. This "mock-up" period will also allow for the training and familiarization of Plant O&M personnel with the conditions, controls, and job coverage that will be implemented during actual Hot Operations. Additional details concerning the overall strategy for achieving radiological operational readiness is documented in PL-OP-8524, *SWPF Plant Operations Radiological Mock-up Plan*[51].

14.0 SWPF COGNIZANT SYSTEM ENGINEERING PROGRAM

The SWPF CSE Program is described in P-ESR-J-00035, *SWPF Cognizant System Engineering Plan*[52]. A major component of the CSE Program during the Construction and the Commissioning and Testing phases is the CM of the design and construction documentation. The CSE Program implements the requirements of Chapter V, System Engineer Program of DOE O 420.1C Chg.1[42].

The CSE Program is being phased in (started during Construction) with applicable elements related to CM control having been initiated. The Program will be fully implemented before the start of Cold Commissioning. The CSE Plan defines sequencing of the implementation. The CSE Program ensures that CSEs participated in Construction verification and system turnover to Commissioning and Testing and will continue to participate in testing, commissioning and maintenance aspects of their assigned systems. CSE formal system health assessments will begin six months after operations have commenced. CSEs will also perform required operability assessments to determine compliance on an as-needed basis.

The CSE Program consists of the following key program elements:

- Identifying the SSCs that are included in the scope of the CSE Program;

- Defining the qualifications, training, roles, and responsibilities for the CSEs;
- Addressing CM requirements for the CSE Program;
- Defining CSE support for O&M; and
- Applying a graded approach for CSE Program implementation.

15.0 READINESS PLAN

SWPF will employ a series approach to achieving readiness. The approach is fashioned after the successful execution of numerous contemporary Readiness Reviews in the DOE complex that were instrumental in achieving readiness. SWPF plans to use a Readiness Assistance Team (RAT) and a Readiness Certification Assurance Board (RCAB) to validate the line management readiness progress and assist in the preparation of affirmations attesting to the particular area being certified as ready. The Project will use Performance Based Criteria that are clearly mapped to DOE O 425.1D Chg. 1 (the Order)[5] core requirements in order to establish that readiness has been achieved.

Program adequacy, implementation verification interviews and field observations will be used to demonstrate that core requirements of the Order[5] are satisfied. Safety Management Program adequacy and implementation will be of particular focus. Responsible line managers will prepare and present evidence of readiness for responsible areas. The RCAB is a team of senior line-experienced personnel who serve to assist the Project Manager in validating a suite of activities necessary to provide assurance that plans, procedures, personnel and the plant are indeed ready for safe, compliant, and unrestricted operations. Board composition is subject to change based on need. The RCAB will report to the Project Manager and deliberate as necessary to assure activities are ready to proceed as planned. The specific functions of the Board are contained in the Board Charter that is approved by the Project Manager.

Approximately 12 months prior to Cold Commissioning, SWPF line management will submit a Startup Notification Report (SNR) for initial startup of the SWPF. The SNR will identify the SAA as the Secretary of Energy (or designee) according to Contractor Requirements Document (CRD) 2.a.(1) [5] of the Order[5]. The SNR will recommend a CORR followed by a DOE ORR as required by CRD 2.b.(2) of the Order[5].

As discussed in DOE-STD-3006-2010[6], at least six months before the date for achieving readiness, SWPF line management must develop the Contractor Operational Readiness Review POA which will describe the scope of the CORR. However, based on a Construction Project Review (CPR) recommendation, the POA was submitted for approval approximately 18 months prior to the CORR. The reason for early submission of the POA is to identify the CORR Team Lead sufficiently early to allow effective coordination and review of activities that may occur prior to the on-site CORR review. The POA provides a clear discussion of the physical and geographic scope of the CORR and a clear description of the SSCs, individual processes, and programs that are within the scope of the CORR using the safety basis as the starting point for that discussion.

The POA designates the proposed CORR Team Leader. The CORR Team Leader qualifications include: Technical familiarity with the activities and functional areas being reviewed; previous performance-based review experience or training; demonstrated leadership and managerial skills, including seniority in relation to the members of the Readiness Review (RR) team to permit smooth management of the RR team; RR experience or formal training; and knowledge of the facility, activity or operation. As discussed in DOE-STD-3006-2010[6], one or more Senior Advisors are recommended for both the Contractor and DOE ORRs. The Team Leader has the prerogative to select Senior Advisors, which is expected for both the SWPF CORR and DOE ORR. The Team Leader and Senior Advisor(s) will not have been assigned direct line management responsibility for the work being reviewed.

The POA addresses the core requirements of the Order [5]. The POA also defines the depth or tailoring for each core requirement to describe more fully the total required scope of the CORR. It is expected that the SRS LWO will have readiness activities for the various facility and program changes needed to support SWPF operations. The SWPF POA includes both physical and operational interface points to clearly identify the scope of the SWPF CORR. SWPF ICDs, as listed in V-ESR-J-00001, *Interface Control Document List*[53], were used to help define these interface points in the SWPF POA. As an example, an expected area of interface is demonstrating readiness to conduct waste transfers and V-ESR-J-00010, *Waste Transfer Interface Control Document (ICD-10)*[54], contains the physical and operational interfaces for these activities.

The POA includes the prerequisites for starting the CORR. The prerequisites define measurable actions or deliverables that, when completed, provide assurance that readiness has been achieved for each core requirement determined to be applicable when developing the scope of the CORR.

SWPF line management submitted the POA to local DOE line management, who then forwarded it to the SAA (Secretary of Energy or designee) for approval. Following SAA approval of the POA, the CORR Team leader will assemble a review team to assist in preparation of the Implementation Plan (IP) and associated Criteria, Review, and Approach Documents (CRADs). The CRADs incorporate the complete review scope specified in the POA, and the IP specifies the methodology for conducting and the process and format for documenting the review. The IP summarizes the prerequisites for starting the CORR, including those specified in the POA. The CORR Team Leader will approve the IP, and then submit the IP to DOE for information.

During Cold Commissioning, SWPF line management will perform MSA-3 to assist in achieving readiness, and to verify POA prerequisites have been satisfied. When readiness has been achieved, SWPF line management will submit a Readiness to Proceed Memorandum, certifying that the SWPF has achieved readiness and the prerequisites in the POA have been met, and a manageable list of open prestart items. Prior to commencing the CORR, SWPF line management must issue the Readiness to Proceed Memorandum.

The CORR Team Leader will assemble the review team to conduct the CORR. The review team may be comprised of senior management personnel and technical experts from the EPC, its Teaming Partners, and its subcontractors. Review team members must meet qualification and training requirements, and have no direct line management responsibility for the work being

reviewed. DOE-SR and DOE-Headquarters may assign observers as part of the DOE Validation Review.

In accordance with Order[5], the CORR will be conducted consistent with the approved IP. The IP will define the ORR scope as described in the approved POA. The CRADs will define the physical scope, including facilities, systems, and processes. CRADs will also define normal plant operations and off-normal event responses, including alarm responses and Emergency Preparedness drills. The CRADs will evaluate the results of the IVR as well as the adequacy of management systems and procedures, competence of staff, and completeness of the Commissioning and Testing Program to protect the public and environment. The CRADs will also evaluate site interfaces with the SWPF.

After pre-start issues have been resolved and corrective actions satisfied, the SWPF Project Manager will submit a Readiness to Proceed Memorandum to DOE line management with a copy of the CORR Final Report and documentation of resolution of pre-start findings. When the prerequisites specified in the DOE POA have been completed, the DOE ORR Team will commence the DOE ORR. The DOE ORR will be full breadth, separate, and independent from the CORR.

Upon completion of the DOE ORR, the DOE ORR Team will prepare an ORR Final Report and the SWPF line management will develop and implement corrective actions for pre-start findings under their purview. SWPF line management will verify closure of pre-start findings with DOE validation, and submit a Certification of Readiness for Hot Operations (Contract Deliverable 5.9B[1]). At this point, the SAA shall provide the startup letter of authorization. The SWPF line management will then request the SRS LWO Contractor to transfer the first batch of waste feed to the SWPF, in accordance with Hot Commissioning procedures and V-ESR-J-00010[54].

15.1 Readiness Procedures

SWPF Readiness procedures will be developed to address the various aspects of the Order[5], including RR preparations, execution and issue resolution. As required by the Order[5], these procedures must be concurred with by DOE SWPF Federal Project Director.

16.0 STARTUP PLAN

NOTE: The LWO Contractor will have performed their own Readiness Assessments and developed a stand-alone LWO Startup Plan, in accordance with DOE O 425.1D Chg. 1[5], to support SWPF Startup activities.

As required by Core Requirement 11 of the Order[5], following SAA approval, SWPF line management will commence operations according to the provisions of V-PMP-J-00041, *SWPF Startup Plan* (DRAFT). SWPF line management will follow the sequence of deliberate operations and oversight identified with particular emphasis on compliance with the limitations and compensatory measures specified in the plan to achieve safe, unrestricted Hot Operations.

The startup plan will be a stand-alone document. Other plans and schedules affecting startup will be summarized in the startup plan. The plan will detail implementation of site, management and facility activities necessary to achieve full operations and specific management observer responsibilities. The plan will focus on those operations that could not be demonstrated or that may be conducted for the first time with the radioactive hazard present.

The details of the initial Hot Operations period are defined in the startup plan. These details will provide formalized and structured initial Hot Operations. Salient features of the plan will include any compensatory measures and increased management oversight expectations, final equipment testing to be completed during Hot Commissioning, as well as the implementing Hot Commissioning procedures.

As a minimum, the startup plan will identify actions to be taken from the time of DOE ORR completion until DOE approval to begin operations. It will include activities to be completed after DOE approval to begin operations up to the point of introducing radioactive material, and the sequence of activities to be completed as part of initial introduction of radioactive material. The plan will also address the following:

1. Identification of facility management observers necessary for initial operations oversight
   a) This will be a list of management personnel assigned to conduct initial operational evaluations of the graded operations testing. Summary-level duties, responsibilities, and shift staffing requirements (i.e., specific duties and responsibilities should be listed in the remaining sections of plan), recordkeeping expectations, and the specific qualifications required of each individual will be included.
2. Equipment operability
   a) This will identify and describe the integrated tests planned and required to confirm operability of equipment during initial operations. The purpose and a summary of the testing acceptance criteria will be included. As discussed in Section 17.0, these tests will include the following minimum Hot Commissioning performance tests required by the Contract[1]:
      i) Shielding - To verify radiation levels are within design criteria. As discussed in SRR-LWP-2009-00001, *SRS Liquid Waste System Plan*, Revision 20[55], the initial batch of waste feed will be limited to less than or equal to 1.0 curie per gallon and this feed is not expected to be exhausted by the conclusion of Hot Commissioning. However, the lower curie content feed is sufficient to confirm radiation levels are within design criteria. Additional shielding surveys will be taken during transition to high curie content feed that occurs after Hot Commissioning is complete.
      ii) Process Capacity - To include processing two consecutive batches at a rate that demonstrates $\geq$ 7.3 Mgal/year. Unit operations (ASP and CSSX) must process the specified number of batches.
      iii) Environmental Testing - To include stack radioactivity monitoring and as specified in regulations/permits.

b) A list of management responsibilities for approving the commencement of testing and management observer oversight of test performance will be included, as well as management approval requirements for key events or progression to the next phase of testing.

c) A summary-level schedule that clearly illustrates the systematic approach to full operations will be provided.

3. Procedure viability

a) This will identify and describe the mechanism for verifying the viability of procedures during actual performance, including requirements for management observer participation in the first-time execution of procedures. The primary, first-time execution procedures are expected to include, but not be limited to, the following:

i) Waste transfer from Tank Farm Feed Tank (TK-49) to AST-A (TK-101).

ii) Waste transfer from DSSHT (TK-207) to TK-50.

iii) Waste transfer from SSRT (TK-104) to DWPF.

iv) Waste transfer from SEHT (TK-205) to DWPF.

b) Laboratory sampling and analysis activities will be identified.

c) The process for procedure changes resulting from the identification of inadequacies in the field will be summarized. Any provisions for increased procedure revision support during the initial execution of procedures will be included.

4. Operator performance

a) This will identify and describe the mechanism for real-time, in-plant management observer evaluations of operator performance to verify the adequacy of operator training.

b) This will also identify and describe the established mechanism for remediating any identified weaknesses.

Details of the startup plan will be evaluated during the CORR and DOE ORR (per Core Requirement 11 of the Order[5]) that ensure initial Hot Operations are formalized and structured.

17.0 TRANSITION TO HOT OPERATIONS

17.1 Hot Commissioning Testing

Standard 5 Contract[1] commitment:

Hot Commissioning: During hot commissioning, the Contractor shall conduct all necessary operations to ensure that the facility is ready for sustained hot operations. During hot commissioning, all products and secondary wastes shall be produced in accordance with the WAC of the receiving facility. Hot commissioning activities may be performed sequentially or in parallel. Hot Commissioning Testing will be performed to verify those aspects of plant design that could not be fully verified in cold commissioning (e.g., shielding, environmental testing, and Cs, Sr, and actinide removal). The results shall be provided to DOE for review and approval.

(1) Certification of Start of Hot Commissioning: The Contractor shall certify to DOE that the facility hot commissioning has started (Table C.5-5.1, Deliverable 5.10, Milestone M6). Start of hot commissioning is defined as having received the first batch of actual tank waste feed.

(2) Hot Commissioning Performance Tests: The Contractor shall carry out hot commissioning performance tests as defined in Table C.5-5.1 below.

Table C.5-5.1 Hot Commissioning Performance Testing

Requirement	***Criterion***	***Measure***
Shielding	*Radiation levels*	*Radiation levels within design criteria.*
Process capacity	*Meet throughput requirements*	*Process 2 consecutive batches at a rate that demonstrates ≥7.3 Mgal/year. All unit processes (ASP, CSSX, and AFP) must process the specified number of batches.*
Environmental Testing	*Stack radioactivity concentrations*	*As specified in regulations/permits*

(3) Environmental Performance Test: The Contractor shall perform environmental testing as required under the Air Permitting Requirements, and applicable Federal, State, and local laws, regulations, and permits to demonstrate the operation of the SWPF in accordance with the regulatory requirements. The results of the testing shall be reported in accordance with permitting and regulatory requirements (Table C.5-1.1, Deliverable 5.11).

(4) Hot Commissioning Results and Documentation: The Contractor shall provide all results from hot commissioning testing to DOE in accordance with the Commissioning Plan (Table C.5-1.1, Deliverable 5.12). The information shall be in the form of controlled copies updated by the Contractor, or electronic access at the Contractor's discretion. Information shall include, but not be limited to results of testing, test deviations and resolutions to test deviations.

(5) Certification of Completion of Hot Commissioning: The Contractor shall certify to DOE that the hot commissioning is complete and the SWPF is operating as designed (Table C.5-1.1, Deliverable). This certification may be combined with the hot commissioning results (Table C.5-1.1, Deliverable 5.12).

The overall objective of Hot Commissioning is to demonstrate that the SWPF is ready to commence unrestricted Hot Operations. During the Hot Commissioning phase, aspects of integrated facility operation will be demonstrated including unit operations, radioactive waste feed receipt from the Low Point Pump Pit, and waste product transfer to HTF Tank 50 and DWPF. The plant will be operated using approved plant operations and support procedures. The major categories of testing that will be conducted are Radiation Shielding Performance Testing, Process Capacity Performance Testing, and Environmental Performance Testing. Activities will be controlled in accordance with the approved Startup Plan, as indicated by Core Requirement 11 of DOE O 425.1D Chg. 1[5].

In accordance with the SRS Liquid Waste System Plan (SRR-LWP-2009-00001[55]), the initial tank farm feed batch to the SWPF is planned to be less than or equal to 1.0 curies per gallon at 6.44 molar (M) Na. Use of feed with reduced activity level will limit risks associated with system upsets and will be used to confirm radiation shielding adequacy. To further reduce risk, the plan is to further dilute incoming feed in AST-A with salt solution simulant used during Cold Commissioning. The initial batch would be diluted to approximately 0.1 curies per gallon with subsequent AST-A batches diluted to higher curie content levels until reaching the full curie content of the Tank Farm initial batch of less than or equal to 1.0 curies per gallon. Because the feed is real waste with radioactive contaminants, the Operations staff will have the opportunity to optimize unit operations before higher-concentration feeds are received.

After the unit operations have been adjusted for optimum performance on reduced curie content feed, higher concentration mini-batches of feed will be processed. Plant systems and equipment will be adjusted and the timing and sequencing of steps will be further optimized at each higher concentration of feed processed.

Test procedure guidance documents will be prepared for execution of Hot Commissioning testing. These test procedures will be approved by the CRB prior to use and will invoke normal plant operating and administrative procedures for test, operational, and maintenance activities.

17.1.1 Project Transition to Operations Plan

As required by DOE O 413.3B Chg. 2, *Program and Project Management for the Acquisition of Capital Assets*[56], a Project Transition to Operations Plan will be developed by Operations and approved by the DOE SWPF Federal Project Director.

17.1.2 Radiation Shielding Performance Testing

As RLW is introduced into the SWPF processes, radiation protection personnel will perform and document dose-rate measurements throughout accessible areas of the facility. These measurements will be reviewed against the forecasted dose rates based on the actual Cs-137 concentrations introduced into the facility. From this data, Radiation Protection can extrapolate anticipated dose-rates in accessible areas based on Cs-137 concentrations, as they vary with the inbound waste. These measurements will serve as verification, or will identify anomalies, respective of the shielding calculations performed during the Design phase of the Project.

17.1.3 Process Capacity Performance Testing

The primary overall test objective is to demonstrate continuous operation of the integrated plant processes for at least two consecutive full batches of actual waste product feed at or above the Peak Throughput of greater than or equal to 7.3 Mgal/yr. Each batch is processed to meet the required WAC limits. The volume credited will be the volume of waste originally received in AST-A corresponding to the batch of waste transferred out of the DSSHT. Production of a corresponding volume of SE in the SEHT ready for transfer to DWPF and MST/sludge ready for washing in the SSRT is also required to obtain credit for processing each batch. Analytical analyses supporting the production rate are to be demonstrated. The WAC for DWPF and Tank 50/SPF shall be met.

17.1.4 Environmental Performance Testing

The environmental monitoring program is categorized by American National Standards Institute (ANSI)/Health Physics Society (HPS) N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities*[57], as a Potential Impact Category 3, mandating periodic confirmatory sampling and off-line analysis. During Hot Commissioning, the plant stack sampling system will be tested to ensure conformance with the requirements of ANSI/HPS N13.1-1999[57].

During Hot Operations, stack sampling and analysis will be dictated by ANSI/HPS N13.1-1999[57] and SRS site-wide air permit requirements.

17.2 Hot Commissioning Results and Documentation

A final Hot Commissioning Test Report will be prepared by Operations and approved by the CRB. This report will document the Hot Commissioning test results, test deviations, and resolution of test deviations, including the results of the environmental performance testing. This report will be provided to the DOE for information purposes to meet Contract Deliverables 5.11

and 5.12[1]. This report will also certify that Hot Commissioning has been completed and that the facility is fully capable of operating as designed. This certification meets Contract Deliverable 5.13[1].

Upon CRB approval of Hot Commissioning test results, the SWPF will transition into full Hot Operations in accordance with an approved startup plan.

18.0 CYBER SECURITY

V-PMP-J-00046, *SWPF Plant Control and Monitoring System Information System Security Plan*[58], provides an overview of the security requirements of the SWPF Plant Control and Monitoring System and describes the controls in place or planned for meeting those requirements. This plan also delineates responsibilities and expected behavior of all individuals who will access the system. It includes the documentation of the structured process for planning adequate, cost-effective security protection for the system.

19.0 REFERENCES

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[3] 29 CFR 1926, Labor: Subtitle B: Regulations Relating to Labor: Chapter XVII: Occupational Safety and Health Administration, Department of Labor: *Safety and Health Regulations for Construction*.

[4] 29 CFR 1910, Labor: Subtitle B: Chapter XVII: Occupational Safety and Health Administration, Department of Labor: *Occupational Safety and Health Standards*.

[5] DOE O 425.1D Chg. 1, *Verification of Readiness to Start Up or Restart Nuclear Facilities*. U.S. Department of Energy, Washington, D.C. April 16, 2010.

[6] DOE-STD-3006-2010, *Planning and Conducting Readiness Reviews*. U.S. Department of Energy, Washington, D.C. May 6, 2010.

[7] PL-NS-5500, *SWPF Safety Basis Implementation Plan*. Parsons, Aiken, South Carolina.

[8] V-IM-J-00001, *SWPF Organization, Roles, and Responsibilities Manual*. Parsons, Aiken, South Carolina.

[9] PL-OP-8521, *SWPF Plant Operations Staffing Plan*. Parson, Aiken, South Carolina.

[10] PL-OP-8530, *SWPF Plant Proficiency Plan*. Parsons, Aiken, South Carolina.

[11] 00-700-26647, *Approach for Execution of Reference 1*. Frank Sheppard to Mike Pittman. July 11, 2018.

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Appendix A. System and Integrated System Operational Tests

Test Number	Test Title
ISOT-BOP-001	Balance of Plant
ISOT-CSX-001	Caustic-Side Solvent Extraction
ISOT-ASP-001	Alpha Strike Process
ISOT-AFF-001	Alpha Finishing Process
ISOT-CCA-001	Cold Chemical Area
SOT-ACC-001	Access Control
SOT-ADS-001	Air Dilution System
SOT-AFD-001	AFF Drains
SOT-AFP-001	Alpha Finishing Process
SOT-AIR-001	Plant Air
SOT-APP-001	APA Sparge and Purge Flow Rates
SOT-ASD-001	Alpha Strike Drains
SOT-ASP-001	Alpha Strike Process
SOT-BA-001	Barium Decay
SOT-CAU-001	Caustic System
SOT-CDS-001	CSSX Drains System
SOT-COM-001	Radio and Public Address
SOT-CON-001	Contactors
SOT-CTV-001	CCTV System
SOT-CTW-001	CSSX Tempered Water
SOT-CWAF-001	Chilled Water Secondary AFF
SOT-CWAS-001	Chilled Water Secondary ASP
SOT-CWBV-001	Chilled Water Primary Ventilation
SOT-CWCR-001	Chilled Water Primary - Control Room System
SOT-CWP-001	Chilled Water Primary
SOT-CWT-001	Caustic Wash Tank
SOT-DIW-001	Deionized Water
SOT-DOM-001	Domestic Water
SOT-DSS-001	Decontaminated Salt Solution Hold Tank System
SOT-FDS-001	Fire Detection
SOT-FLS-001	Flush Water System
SOT-FSS-001	Fire Suppression
SOT-HRS-001	Heat Recovery System

Appendix A. System and Integrated System Operational Tests (cont.)

Test Number	Test Title
SOT-ICP-001	Instrument Control Panel
SOT-IST-001	Intermediate Storage Tank
SOT-LAB-001	Hot Cells, Gloveboxes, Radio Hoods
SOT-LAB-002	Sample Pumps
SOT-LC-001	Lab Collection
SOT-LD-001	Lab Drain
SOT-LLD-001	Low Level Drains
SOT-MHD-001	Material Handling
SOT-MST-001	Monosodium Titanate System
SOT-MSTT-001	MST/Sludge Transfer Tank System
SOT-NEU-001	Neutralization
SOT-NIT-001	Nitric Acid
SOT-OAS-001	Filter Cleaning
SOT-PMS-001	Power Monitoring System
SOT-PMV-001	Pulse Mixer Ventilation
SOT-PSL-001	Pump Seal Flush
SOT-PVV-001	Process Vessel Ventilation
SOT-RMS-001	Radiation Monitoring
SOT-SDG-001	Standby Diesel Generator
SOT-SES-001	Strip Effluent System
SOT-SFD-001	Solvent Strip Feed
SOT-SHT-001	Solvent Hold Tank
SOT-SIS-001	Safety Instrumented System
SOT-SMU-001	Solvent Makeup System
SOT-SSF-001	Salt Solution Feed
SOT-SSR-001	Sludge Solid Receipt & Wash Water Hold
SOT-VAF-001	AFF Ventilation
SOT-VCB-001	Compressor Building Ventilation System
SOT-VCC-001	Cold Chemical Ventilation
SOT-VCR-001	Control Room HVAC System
SOT-VMS-001	Vibration Monitoring System
SOT-VPB-001	Process Building Ventilation

Appendix B. Performance Test Simulants and Chemicals

Sludge simulant and salt solution simulant will be introduced during IWRs and used to support testing and cold commissioning activities. Other process chemicals used will be prototypic for the SWPF (e.g., MST, solvent, NaOH, HNO_3) and will also be introduced during IWRs.

The simulant recipes are based on the SRS RLW, and at least one strike batch will be spiked with non-radioactive Sr and the initial SSFT (TK-109)/FFT-A (TK-102) contents will be spiked with non-radioactive Cs. The simulant recipe will possess feed characteristics, including chemical constituents, comparable to actual RLW feed. However, certain expected components of the actual waste feed will be omitted (e.g., Resource Conservation and Recovery Act [RCRA] listed metals and some organics) to minimize disposal problems and costs, as discussed below.

Sludge Simulant

The process feed salt solution as received from the SWPF feed tank will contain a sludge solids concentration of 0.6 grams per liter (g/L). The same amount of solids will yield sludge solids concentration of 0.5 g/L in a 28,200-gallon batch (0.004 pounds per gallon [lbs/gal]). Therefore, about 113 lbs of sludge solids in a 15 wt% slurry will be required to make up a 28,200-gallon batch of salt solution simulant.

The sludge simulant will be prepared in accordance with specification SPC-ME-6204-0004, *SWPF Sludge Simulant*[1].

Salt Solution Simulant

The primary functional requirement of the SWPF salt solution simulant utilized during Cold Commissioning performance testing is to sufficiently emulate the waste feed to ensure prototypic performance is demonstrated. Secondarily, utilization of a salt solution simulant with comparable composition to salt solution simulants used in past testing will allow a direct comparison to past performance. Consistency of the salt solution simulant composition is also a consideration, as this ensures that system performance responses to changes in operating conditions are correctly interpreted.

The salt solution simulant formulation for dilute feed (5.6M [Na^+]) is provided in Table B-1 and is similar to that previously used in SWPF CSSX testing, with a few exceptions. Sr was not used as a salt solution simulant component in previous CSSX testing. In addition, concentrations of aluminum (Al) and silicon have been altered to reflect the SWPF WAC limits. The nitrate (NO_3^-) concentration was adjusted as a result of lowering the Al concentration to ensure a charge balance at 5.6M [Na^+].

Appendix B. Performance Test Simulants and Chemicals (cont.)

The salt solution simulant recipe is based on the average, dilute waste simulant recipe specified in WSRC-RP-2000-00361, *Preparation of Simulated Waste Solutions for Solvent Extraction Testing*[2]. Exceptions to this recipe are the removal of RCRA metals, ammonium nitrate, fission-product metals (i.e., ruthenium, rhodium, and palladium), and trace organics (not including di-butyl phosphate). The performance impact resulting from the addition of these chemicals was determined to be insignificant in comparison to the industrial hygiene concerns and the attendant difficulties in waste disposal. The concentration of Cs also varies from that referenced in WSRC-RP-2000-00361[2] and is equivalent to the WAC limits specified in X-ESR-J-00001, *SWPF Feed Waste Acceptance Criteria*[3]. The proposed salt solution simulant Cs concentration is consistent with the total Cs in the salt feed at the ^{137}Cs SWPF WAC limit of 5.25 curies per gallon in 6.44M [Na^+] salt waste. ANL-01/10, *Interim Report on a Multi-day Test of the Caustic-Side Solvent Extraction Flowsheet for Cesium Removal from a Simulated SRS Tank Waste*[4], reported that 22.6 wt% of total Cs in the waste was ^{137}Cs. The Cs concentration utilized is equivalent to the total Cs concentration (^{133}Cs and ^{137}Cs) expected in the SWPF feed. The target ion concentrations for each salt solution simulant formulation, 5.6M [Na^+] or 6.44M [Na^+], are presented in Table B-1.

The formulation for concentrated salt simulant feed (6.44M [Na^+]) is also provided in and was determined by using the composition at 5.6M [Na^+] and calculating the concentrated composition using the dilution ratios used in the Mass Balance Model (see P-ESR-J-00001, *Mass Balance Model Summary Description*[5]).

Sr will be a salt solution simulant constituent for testing of the ASP, but is not required for testing of other subsystems. The salt solution simulant target doping concentration of non-radioactive Sr was established by reviewing several Savannah River National Laboratory tests involving Sr at 5.6M [Na^+] and picking the highest value achieved (9.27 mg/L) from Table 4 of WSRC-STI-2006-00012, *Results of Supplemental MST Studies*[6]. The 6.44M [Na^+] value was obtained using the 5.6M [Na^+] value adjusted using the appropriate mass balance model ratio. These will be target values for chemical addition, but due to Sr precipitation, the final concentration is expected to be lower. The target non-radioactive Sr concentrations are included in Table B-1 for the 5.6M [Na^+] and 6.44M [Na^+] formulations.

Hardware hydraulic performance is driven by the bulk physical properties of the fluids being processed. Salt solution properties that have an effect on hydraulic performance include density and viscosity. The major effect on these physical properties results from changes in the total salt concentration. The specific ion concentrations will only have a minor effect on physical properties relative to the effect of total ionic strength (WSRC-RP-89-1088, *Viscosity and Density of Simulated Salt Solutions*[7]). Density is a very good direct measurement of total salt concentration in simulated and actual salt wastes.

Appendix B. Performance Test Simulants and Chemicals (cont.)

The composition of the actual waste feed to SWPF will have some variability. Thus, strict maintenance of the simulant density is not necessary. However, the density should be maintained within a tolerance envelope to ensure proper hardware hydraulic performance and also to ensure that the actual waste is conservatively emulated.

As previously discussed, specific anion concentrations only have a minor effect on physical properties and hydraulic performance. However, the specific concentrations of potassium [K^+], hydroxide [OH^-], and NO_3^- will effect Cs mass transfer performance. The relationship between Cs distribution coefficients (D_{Cs}) and [K^+], [OH^-], and [NO_3^-] has been published (Solvent Extraction and Ion Exchange, V28, 19-48)[8]. The actual concentration of [K^+] is not critical as the actual waste will have significant batch-to-batch variation and the relationship between [K^+] and D_{Cs} has been empirically correlated. Unlike K^+, the specific concentrations of Sr and Cs are not expected to impact mass transfer performance. However, they will need to be sufficiently high in order to measure mass transfer performance.

The following acceptable ranges for density are based on direct experience mixing in excess of 600,000 gallons of complex salt solution simulant to support SWPF testing programs:

- 5.6M [Na^+] simulant density: 1.235 ± 0.025 grams per cubic centimeter (g/cc).
- 6.44M [Na^+] simulant density: 1.275 ± 0.025 g/cc.

The acceptable specific ion concentrations below are sufficient to demonstrate the SWPF design with respect to mass transfer. Note the maintenance of these ion concentrations in the salt solution simulant feed is only necessary for testing involving measurement of mass transfer performance.

- K concentration in simulants: 15 – 50 millimolar.
- Cs concentration in simulants: ≥ 1E-4M[B].
- Sr concentration in simulants: ≥ 1E-6M.

[B] At very high non-prototypical Cs concentrations (i.e., 1E-3M) the Cs DF will be artificially negatively impacted due to saturation of Calix[4]arene-bis(tert-octylbenzo-crown-6) extraction sites.

Appendix B. Performance Test Simulants and Chemicals (cont.)

Table B-1. Target Ion Concentrations for 5.6M and 6.44M [Na^+] Salt Solution Simulants

Ionic Species	Concentration for 5.6M [Na^+] (M)	Concentration for 6.44M [Na^+] (M)
Sodium (Na^+)	5.58E+00	6.42E+00
Potassium (K^+)	1.50E-02	1.80E-02
Nitrate (NO_3^-)	1.82E+00	2.19E+00
Cesium (Cs^+)**	4.30E-04	5.16E-04
Chloride (Cl^-)	2.45E-02	2.94E-02
Hydroxide (OH^-)*	3.19E+00	3.54E+00
Nitrite (NO_2^-)	5.00E-01	6.00E-01
Aluminum (Al^{3+})	2.08E-01	2.50E-01
Carbonate (CO_3^{2-})	1.50E-01	1.80E-01
Sulfate (SO_4^{2-})	1.40E-01	1.68E-01
Oxalate ($C_2O_4^{2-}$)	8.00E-03	9.61E-03
Molybdate (MoO_4^{2-})	7.86E-05	9.44E-05
Copper (Cu^{4+})	2.22E-05	2.67E-05
Zinc (Zn^{2+})	1.24E-04	1.49E-04
Iron (Fe^{3+})	2.55E-05	3.06E-05
Tin (Sn^{2+})	1.99E-05	2.39E-05
Fluoride (F^-)	2.80E-02	3.36E-02
Monohydrogen phosphate (HPO_4^{2-})	7.00E-03	8.41E-03
Strontium (Sr^{2+})**	1.06E-04	1.27E-04

* The OH^- concentration specified is the target amount added to the simulant. The actual free OH^- concentration is expected to be lower as a result of secondary reactions, particularly with aluminum nitrate.

** For those batches requiring DF demonstration

Appendix B. Performance Test Simulants and Chemicals (cont.)

Reconstituted Salt Solution Simulant

The DSS from CSSX Performance Testing may be recycled and reconstituted as needed to complete the Performance Test Objectives. Chemical reconstitution options include full reconstitution to the Table B-1 target concentrations for 5.6M [Na^+], reconstitution of only the major components (i.e., NaOH, sodium nitrate, and sodium nitrite), reuse of a simulant batch without reconstitution, or a combination of these options. The reconstitution decision will be based on evaluation of SWPF response to varying simulant density and composition during PVT partial batch runs conducted prior to the DCPT. The specific reconstitution requirements will be specified and approved in the run plan for the DCPT.

In addition to the two (2) formulations provided in Table B-1, simulant salt solution concentrations other than 5.6M and 6.44M [Na^+] may be used to minimize non-prototypic reconstitution operations and allow a larger range of feed concentrations (both higher and lower than the nominal 5.6M [Na^+]) to be tested. For example, starting with a 5.78M [Na+] simulant could allow a batch to be processed twice without substantial reconstitution. The 5.78M [Na^+] simulant would be diluted by approximately 6.25 percent (%) via scrub dilution in CSSX to 5.42M [Na^+] in the first pass. The 5.42M [Na^+] batch could be recycled for a second pass after addition of only pre-dissolved non-radioactive Cs and Sr (if applicable). In this scenario, the number of reconstitution operations would be reduced by half, and at least three different simulant compositions would be tested during the DCPT, including 5.6M (from the 6.44M batch diluted in AST-A [TK-101]), 5.78M, and 5.42M. The formulations of a more or less concentrated salt simulant solutions (i.e., >5.6M [Na^+]) would be based on linear interpolation between the 5.6M and 6.44M [Na^+] or extrapolation below the 5.6M formulations provided in Table B-1.

Similar to the selected reconstitution option, simulant compositions other than the nominal 5.6M and 6.44M [Na^+] will be approved in the DCPT run plan.

Other Feeds, including MST, Caustic Dilution, Strip, Scrub, and Wash Solutions

Actual MST will be used for testing.

Process feed will be required for chemical adjustment as needed and will consist of the following process solutions:

- Spent process solutions or simulant in Alpha Sorption Drain Tank (ASDT) (TK-601) adjusted to a nominal 1.66M NaOH. (Spent solutions include cleaning rinse water, laboratory waste, and Pulse Mixer Ventilation System condensate);
- Wash water from the Wash Water Hold Tank (WWHT) (TK-105) simulated by a nominal 1.66M NaOH since wash water will not be available until after sludge washing;
- Nominal 1.66M NaOH from the Caustic Dilution Feed Tank (TK-108); and
- Spent filter cleaning solution or simulant adjusted to a nominal 1.66M NaOH from the Spent Acid Storage Tank (TK-127).

Appendix B. Performance Test Simulants and Chemicals (cont.)

Other feeds will be prototypic of normal SWPF operations and will be prepared to their respective standards using SWPF equipment and chemicals originating from the CCA.

References

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