Office of Enterprise Assessments
Review of the Savannah River Site
Salt Waste Processing Facility
Construction Quality and Startup Test Plans

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Table of Contents

Acronyms iii

Executive Summary iv

1.0 Purpose 1

2.0 Scope 1

3.0 Background 1

4.0 Methodology 2

5.0 Results 2

5.1 Construction Quality Review 3

5.2 Review of the Startup Test Program 7

6.0 Conclusions 14

7.0 Opportunities for Improvement 15

8.0 Items for Follow-Up 17

Appendix A: Supplemental Information A-1

Appendix B: Documents Reviewed, Interviews, and Observations B-1

Acronyms

APA	Air Pulse Agitator
ASME	American Society of Mechanical Engineers
ATS	Automatic Transfer Switch
AVD	Attribute Verification Database
BPCS	Basic Process Control System
CFR	Code of Federal Regulations
CG&A	Calibration, Grooming, and Alignment
CPA	Central Process Area
CRAD	Criteria, Review and Approach Document
CRB	Commissioning Review Board
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
ICP	Instrument Control Panel
ISOT	Integrated System Operational Test
ITP	Inspection and Test Plan
JTG	Joint Test Group
NCR	Nonconformance Report
NQA	Nuclear Quality Assurance
OFI	Opportunity for Improvement
PC	Performance Category
PDSA	Preliminary Documented Safety Analysis
PMVS	Pulse Mixer Ventilation System
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
QCIR	Quality Control Inspection Report
SDG	Standby Diesel Generator
SOT	System Operational Test
SRS	Savannah River Site
SS	Safety Significant
SSC	System, Structure, or Component
SWPF	Salt Waste Processing Facility
TBD	To Be Determined
WP	Work Package

Office of Enterprise Assessments Review of the Savannah River Site
Salt Waste Processing Facility
Construction Quality and Startup Test Plans

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA) conducted a review of construction quality and startup test plans at the DOE Savannah River Site Salt Waste Processing Facility (SWPF). EA's Office of Environment, Safety and Health Assessments conducted this review from November 3 to 7, 2014. EA is performing a series of these reviews across the complex to ensure that design and construction of DOE facilities meet the requirements of Title 10 Code of Federal Regulations 830 Subpart A, *Quality Assurance Requirements*.

EA observed ongoing construction work activities including pressure testing and cleaning/flushing of piping and associated documentation, inspected installed equipment such as pipe supports and instrumentation for quality of installation, and reviewed the nonconformance report identification and processing. EA also reviewed the pre-operational and start-up test program including the overall program descriptions, startup test procedure development and procedure quality, and test engineer training.

EA determined that construction quality at SWPF is generally satisfactory in the areas that were reviewed. Parsons Corporation (Parsons) has also adequately documented the process for installing instrumentation and the program for pressure testing and cleaning and flushing of piping systems. Training and qualification of test engineers was generally adequate. Parsons has developed appropriate corrective actions to resolve specific deficiencies for closed nonconformance reports.

However, EA identified needed improvement summarized as follows:

- Some of the system operational tests may warrant additional review and revision to verify test acceptance criteria are appropriate, testing methods demonstrate that equipment performs in accordance with design requirements, and systems are operable and perform as specified in the documented safety analysis.

- Some test plan descriptions were out of date and should be revised to incorporate design changes and the latest processes and procedures developed since start of construction.

Office of Enterprise Assessments Review of the Savannah River Site
Salt Waste Processing Facility
Review of Construction Quality and Startup Test Plans

1.0 PURPOSE

The U.S. Department of Energy (DOE) independent Office of Enterprise Assessments (EA) conducted a review of construction quality and operational test plans at the DOE Savannah River Site (SRS) Salt Waste Processing Facility (SWPF). Parsons Corporation (Parsons) is under contract with DOE to design, construct, and commission the SWPF. EA's Office of Environment, Safety and Health Assessments conducted the onsite portion of this review from November 3 to 7, 2014.

2.0 SCOPE

The scope of this assessment of construction quality included observations of ongoing and completed work activities, review of the Parsons corrective action program, and follow-up on issues identified during previous assessments. EA also reviewed the startup test program described in the commissioning and testing phase following construction turnover in the construction contract. Design and procurement programs were not included in the scope of this review.

3.0 BACKGROUND

The overall mission of the SWPF is to separate and concentrate the radioactive cesium, strontium, and actinide contaminants from the high-curie salt solutions that are to be removed from the liquid waste tanks in the F- and H-Area Tank Farms at SRS. The concentrated strontium, actinide, and cesium waste slurry containing most of the radioactive contaminants will be sent to the Defense Waste Processing Facility for immobilization in a glass formulation by a vitrification process. The decontaminated salt solution left after removal of the highly radioactive contaminants will be sent to the Saltstone Production Facility for immobilization in a grout mixture and disposal in grout vaults at the Saltstone Disposal Facility.

The SWPF is divided into the Central Process Area (CPA), the Cold Chemicals Area, the Facility Support Area, and the Alpha Finishing Facility. Most radioactive materials are stored and processed in the CPA, a reinforced concrete structure. The CPA includes six rooms that contain processing and holding tanks. These rooms are designated as dark cells. The dark cells are shielded rooms for which no maintenance or entry is planned for the 40-year design life of the plant. The CPA is designed to DOE performance category (PC)-3 criteria. The remaining SWPF areas are housed in structural steel buildings designed as PC-1 structures.

The SWPF is being designed and constructed by Parsons. Parsons prepared a preliminary documented safety analysis (PDSA) for the SWPF that describes the facility design codes, safety systems, design basis accident analysis, pre-operational testing program, operational safety, and the quality assurance (QA) program. Construction work is about 80 percent complete, and work currently in progress includes installation of piping and pipe supports; instrumentation lines; the heating, ventilation, and air conditioning systems; electrical cable tray supports; the fire protection system; and electrical cables. The QA program requirements for design, construction, and operation of the SWPF, referenced in the PDSA, are specified in American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1-2004, *Quality Assurance Requirements for Nuclear Facility Applications*, and DOE Order 414.1C,

Quality Assurance. Construction oversight is provided by DOE Savannah River Operations Office staff members in the SWPF Project Office. EA previously performed construction quality reviews at SWPF in May 2012 and January 2014.

4.0 METHODOLOGY

This independent review of the construction quality processes and startup test plans at SWPF was conducted in accordance with the *Plan for the Office of Enterprise Assessments Construction Quality Review at the Salt Waste Processing Facility*, dated November 2014. This assessment included review of documents (i.e., work instructions, procedures, specifications, and drawings); interviews of key personnel responsible for performing inspection and startup testing work activities, inspection of pipe supports, observation of pressure testing and cleaning and flushing of piping, and review of quality records. EA evaluated the programs implemented by Parsons for compliance with the requirements of 10 Code of Federal Regulations (CFR) 830, Subpart A, *Quality Assurance Requirements*; DOE Order 414.1C, *Quality Assurance*; DOE Order 420.1B, *Facility Safety*. Title 10 CFR 830 and DOE Order 414.1C require the contractor to use appropriate national consensus standards to implement DOE QA requirements. The PDSA references ASME NQA-1-2004, *Quality Assurance Requirements for Nuclear Facility Applications*, as the national consensus standard that Parsons will follow as the basis for the SWPF QA program. The QA requirements in ASME NQA-1 are specified in 18 basic and supplemental criteria. Parsons Document number V-QP-J-0001, *Quality Assurance Plan*, describes in detail the application of the 18 NQA-1 requirements to the SWPF. The quality assurance plan (QAP) establishes the planned and systemic actions necessary to provide adequate confidence that a system, structure, or component (SSC) will perform satisfactorily in service. The SWPF QAP incorporates the basic and amplified requirements of the supplemental criteria from NQA-1.

This EA assessment focused on certain portions of the following EA criteria, review and approach documents (CRADs):

- CRAD 45-53, *Construction – Mechanical Equipment Installation*
- CRAD 45-52, *Construction – Piping and Pipe Supports*
- CRAD 31-05, *Review of System Operational Test Plans.*

Supplemental information on the review, including the members of the EA team, the Quality Review Board, and EA management, is provided in Appendix A. A list of key documents reviewed, interviews conducted, and work activities observed is provided in Appendix B.

5.0 RESULTS

Activities examined by EA during the review are discussed below. The inspection criteria are shown in italics, followed by EA activities for the criteria. The inspection criteria are based on DOE orders, DOE standards, the SWPF contract, the SWPF PDSA, the Parsons QAP, and codes and standards referenced in SWPF design analyses and SRS operating requirements. Conclusions are summarized in Section 6, opportunities for improvement (OFIs) are listed in Section 7, and items for follow-up are discussed in Section 8.

5.1 Construction Quality Review

5.1.1 Corrective Action Program

Criteria: A process shall be established to identify, evaluate, and correct conditions adverse to quality. Records shall be maintained documenting the corrective action program, including documentation of objective evidence of satisfactory implementation of corrective actions. (NQA-1, Criterion 16; Section 16 of the SWPF QAP; and DOE Order 414.1C)

Procedure PP-QA-4703, *Nonconforming Items*, defines the requirements for identifying, documenting, evaluating, and correcting items that do not conform to SWPF project requirements. Nonconformance reports (NCRs) are issued to document and disposition nonconforming hardware items or incorrectly performed work. The quality control (QC) manager is responsible for reviewing and validating the nonconforming condition. Examples of nonconforming items include: (1) failure to satisfy technical or design requirements; (2) indeterminate quality of an item; (3) incorrect installation of SSCs (construction errors); (4) failure of personnel to follow procedures, such as bypassing hold points or improperly performing inspections; or (5) documentation deficiencies.

EA reviewed approximately 50 closed NCRs and 40 open NCRs issued by Parsons between April 3 and November 5, 2014, to determine the types of nonconforming issues that were identified and subsequent mechanisms for resolution. Approximately 40 percent of the NCRs are a result of procurement and supplier deficiencies. Parsons initiated a majority of the remaining NCRs to document and disposition construction problems.

The Parsons Engineering organization developed appropriate corrective actions to disposition the specific problems identified in the completed and closed NCRs. Implementation of the corrective action program was adequate to address and resolve procurement and construction quality deficiencies.

5.1.2 Pipe Support Installation

Criteria: Work, such as construction and installation of pipe supports, shall be performed in accordance with approved procedures, design drawings, and other design basis documents, including applicable codes and standards. The procedures, instructions, and drawings shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed results have been satisfactorily attained (NQA-1, Criterion 5; Section 5 of the SWPF QAP; and DOE Order 414.1C). Records shall furnish documentary evidence that items or activities meet specified quality requirements (NQA-1, Requirement 17; Section 17 of the SWPF QAP; and DOE Order 414.1C).

EA reviewed SWPF project procedures and drawings controlling installation of pipe supports, examined a sample of supports that have been completed and accepted by QC, reviewed quality records documenting acceptance of pipe supports, and followed up on OFIs identified in previous SWPF construction quality reviews.

5.1.2.1 Pipe Support Installation Requirements. Design Engineering has prepared approximately 5000 isometric piping drawings that show the locations and types of pipe supports required to support the various SWPF piping systems. The support location tolerances are specified in Paragraph 3.4.3 of Specification Section 15121, *Field Installation of Process Piping*. Section 2.5 of Procedure number DP-CS-7318, *Fabrication/Installation of Process Piping and Pipe Supports*, specifies the requirements for installing pipe supports. Pipe support fabrication details are shown on controlled drawings which specify member types and sizes, weld details, method of attachment to the building structure, and details for attachment of the pipe to the

support. QC inspection requirements for pipe supports are specified in Inspection and Test Plan (ITP) 05120-0001, *Section 05120, Structural Steel (Pipe Supports)*. QC inspection results are documented in a quality control inspection report (QCIR).

5.1.2.2 Inspection of Pipe Supports. EA examined 23 completed pipe supports on various systems, constructed under Work Package (WP) 0606, *Pipe Support Installation and Fabrication, Room 135B, South ASP Labyrinth 2*. Parsons' QC inspectors have inspected and accepted these supports. EA compared the installed pipe supports to the controlled pipe support drawings. Welds were proper type, size, and that support configuration and the length, the size, type of support members were in accordance with design drawing requirements. No deficiencies were identified; Parsons fabricated and installed the pipe supports in accordance with design drawing requirements.

5.1.2.3 Review of Pipe Support Quality Records. EA reviewed WP-0606, *Pipe Support Installation and Fabrication, Room 135B, South ASP Lab 2.* Parsons had completed all but one pipe support in this WP. Documentation in the WP included work steps signed as complete by construction supervision, installation data for concrete expansion anchors, and field welding checklists. The field welding checklists document all data associated with the welds including location, drawing numbers, welding procedure specification, inspection requirements and procedures, preheat requirements, weld filler materials requirements, welder identification, and identification of the QC inspector who inspected the welds. A weld map shows the specific location of each weld. The record of QC inspections performed to accept the work is documented in the WP by referencing the appropriate QCIR numbers. The pipe support field engineers review the WPs to verify all required work has been completed and document their review on piping support checklists. The records for fabrication, installation, and inspections of the pipe supports in the WP are legible, retrievable, and easy to review and also meet the requirements of DOE Order 414.1C for construction quality records.

5.1.2.4 Follow-up on Previously Identified OFIs. EA identified two OFIs during the May 2012 Construction Quality Review. EA noted in one OFI that instead of preparing a detailed project procedure to use for guidance when installing concrete expansion anchors, Parsons provided the craft with pages from the manufacturer's catalog. However, QC inspectors had an inspection procedure, ITP-05120-0002, *Section 05120, Structural Steel (Anchorage for SS/PC-1, SS/PC-3 and GS/PC-3 Equipment)* that contained detailed instructions for inspecting anchors. EA reviewed the NCRs that have been opened by Parsons since March 2013. Eleven of approximately 350 NCRs were initiated to address concrete expansion anchor deficiencies. These deficiencies were minor and isolated. The Design Engineering resolution for 10 of these NCRs was to "use as is," no rework required. Parsons used sound engineering practices to appropriately resolve the remaining NCR and provided effective instructions to the craft for installing the anchors.

The other OFI concerned maintaining the status for installing pipe supports. For the initial installation of pipe supports at SWPF, Engineering prepared sketches showing the location and type of pipe supports required. The sketches were based on a preliminary stress analysis and engineering judgment. When the supports were originally installed, they were classified as temporary. QC inspectors had inspected the supports and documented inspection results on QCIRs referenced on the sketches. However, Construction had not signed any of the installation job steps in the work packages as complete, except those for installation of concrete expansion anchors. Project personnel stated that since the supports were classified as temporary, the work package installation job steps would not be signed until the stress analyses were completed, final isometric drawings were issued, and pipe slopes were verified to be in accordance with those

shown on the isometric drawings. Normally, delaying closeout of the individual job steps in work packages would result in a large backlog of "incomplete" work packages. However, the closeout process being used by the pipe support field engineers for WP closure is effective because the process indicates which supports are still incomplete.

5.1.3 Instrumentation Installation

Criteria: Work, such as installation of instrument tubing, supports, and instrumentation shall be performed in accordance with approved procedures, design drawings, and other design basis documents, including applicable codes and standards. The procedures, instructions, and drawings shall include or reference appropriate quantitative or qualitative acceptance criteria for determining that prescribed results have been satisfactorily attained (NQA-1, Criterion 5; Section 5 of the SWPF QAP; and DOE Order 414.1C).

EA reviewed Specification Section 16910, *Instrumentation Equipment Installation*, and Instrument Installation Detail Construction Drawings, Sheets 1 through 11. Specification Section 16910 defines the technical requirements for installing instrumentation, air supply and impulse tubing, tubing supports, and instrument racks. The construction drawings show typical support details. Specification Section 16910 also includes instructions for cleaning, wiring, labeling, and testing instrumentation and associated components. Horizontal impulse tubing must be installed with a minimum slope of ¼ inch per foot.

EA, accompanied by a Parsons engineer, examined installed instrumentation, instrument racks, instrument tubing, and supports in various areas in the CPA. The Parsons engineer discussed various problems that had been encountered during construction and some issues that Design Engineering is currently evaluating. NCRs have been initiated by Parsons to document the issues undergoing engineering evaluation. EA also reviewed WP-0180, an in process WP for installing instrumentation in Rooms 201, 202, 203, 212, and 213.

Specification Section16910 and the construction drawings are adequate to control installation of instrumentation, tubing, and supports, and also include specific work instructions to ensure that the technical requirements and limitations in the specification are met. EA identified no concerns with the instrumentation installed to date, and the workmanship is adequate.

5.1.4 Pressure Testing and Cleaning and Flushing of Piping Systems

Criteria: Construction and pre-operational tests for piping systems, such as pressure testing and cleaning and flushing operations, shall be conducted in accordance with methods approved by the design organization. Test procedures shall include test requirements, acceptance criteria, test prerequisites, inspection hold points, and instructions for recording data. Testing shall be observed by qualified inspection personnel. Test results shall be recorded and evaluated by qualified personnel. (NQA-1, Criterion 11; Section 11 of the SWPF QAP; and DOE Order 414.1C)

EA reviewed the program for pressure testing and cleaning and flushing of piping systems and observed the pre-test briefing and hydrostatic pressure test of a small spool piece from WP 918. EA also reviewed specifications, procedures, and the WPs that control the processes for pressure testing and cleaning and flushing of piping systems and interviewed the pressure testing and flushing group manager and responsible test engineers. The SWPF code of record for piping is ASME B31.3-2002.

5.1.4.1 Pressure Testing of Piping Systems. Specification section 15112, *Pipe Leak Testing*, defines the requirements for leak testing of piping in accordance with applicable codes specified in design documents. The specification covers both hydrostatic and pneumatic pressure testing

including test pressures, test sequencing, test hold times, and inspection requirements. The SWPF site work process for conducting pipe leak testing is contained in the following procedures: DP-CS-7319, *Leak Test of Process Piping*; DP-CS-7323, *Leak Testing and Flushing Prerequisites;* DI-CS-016, *Instrument Tubing Blowdown and Leak Test;* DI-CS-019, *Sampling and Analysis Instructions for Piping Hydrostatic Test and Flushing*; and DI-CS-020, *Pneumatic Test Exclusion Area and Static Head Correction Factor Determination.*

The design code requirements for conducting pressure testing of piping are specified in ASME Code B31.3, Paragraph 345.4, for hydrostatic testing and ASME Code B31.3, Paragraph 345.5, for pneumatic testing. The pressure test acceptance criteria require visual examination of all pipe welds for leakage. The test process also invokes ASME Code Interpretation 21-42, issued October 2, 2007, which permits use of a pump to maintain test pressure during the 10-minute hydrostatic test duration. Design Engineering had adequately defined the test pressurization criteria, and a process is in place for Design Engineering to review exceptions.

The scope of each pressure test is defined in a WP that lists test requirements, preparation activities, performance, and recovery/restoration from each pressure test and includes pre-job briefing and safety requirements, prerequisites, work instructions, sequence of work activities and applicable construction drawings and other documents necessary to perform the work. The WPs also include engineering responses to construction requests for information. Work steps in the WPs include sign offs and inspection hold points that are based on ITP-15112-0001, *Pipe Leak Testing.* The ITP identifies the inspection attributes and acceptance criteria that QC inspectors are required to inspect and verify during the pressure test. QC inspectors complete a QCIR to document the inspection results and record the QCIR number in the WP.

Individual test plan scopes are well defined, documenting specific scopes with markups of both piping and instrumentation diagrams and piping isometric drawings showing pressure test boundaries. EA reviewed the process used to establish test boundaries. It is sometimes necessary to cut pipe or prevent a closure weld from being made in order for the pressure test group to have access to establish a test boundary, or to avoid over-pressurizing tanks or other equipment. When a pipe must be cut, the test engineer submits a request to Mechanical Engineering for approval. An NCR is issued to document cutting a pipe if that component had been inspected and accepted by QC. Closure welds to restore the pipe cannot be pressure tested and therefore are subject to 100% radiographic examination in accordance with code requirements.

EA reviewed test documentation that included ten test plans in WP-0859, WP-0940, and WP-1086. Six of the test plans had been implemented and were complete. The other four were awaiting turnover of the piping from construction. Each test plan identified the actions required to establish test boundaries such as valve closures, locations of test equipment installation, and modifications made (i.e., removal the valve internals, installing blind flanges, removing sensitive instrumentation). The same form tracked restoration of these components to the original condition. Parsons had issued two NCRs since April 3, 2014, for nonconforming items identified as a result of pressure testing. Parsons adequately corrected and closed these NCRs.

During pressure test preparation, the test procedures clearly specify the requirements for test engineers to ensure that tags are properly placed to identify the pressure test boundaries. However, the process for removal of the tags after completion of the pressure test is not well defined. Since the test plan format does not document tag removal, test performers sometimes leave tags in place after a pressure test is complete. For example, during a walkdown with a test engineer, a craft worker inquired about the status of a tag indicating a test boundary that had been

left in place after completion of a pressure test. Craft productivity was impacted while the test engineer determined the status of the line. The same issue applies to cleaning and flushing plans. (**See OFI-SWPF-01**.)

5.1.4.2 Cleaning and Flushing of Piping Systems. Section 3.9 of Specification 15121, *Field Installation of Process Piping*, specifies the requirements for internal cleaning and flushing of piping including flushing methods, acceptance criteria, draining, and drying of the piping after flushing is completed. The SWPF site work process for conducting pipe leak testing is contained in the following procedures: DP-CS-7321, *Flushing/Cleaning of Process Piping*; DP-CS-7322, *Foreign Material Exclusion*; and PL-CS-7205, *Process Pipe Flush Plan*. Procedure DP-CS-7321 and Specification 15121 contain a table establishing minimum flow rates in gallons per minute for flushing in each relevant pipe size. These flow rates are based on achieving turbulent flows in the pipes, which is necessary for debris removal. Based on a sample of the calculations, EA verified that the minimum flow rate values calculated and published in the Table are sufficient to produce turbulent flow. When flushing operations are performed, flow rates are measured and documented and the effluent is examined to determine if particulates and oil contaminants were present.

In addition to observing cleaning and flushing of the pipe spool in WP 0918, EA also observed flushing of four drain lines installed to discharge potentially radioactive liquid waste from the laboratory glove boxes in WP-0725. Flow rates and flushing times/volumes were in accordance with procedure requirements and complied with the cleanliness criteria after the last flushing cycle. A QA inspector was present to witness the flushing/cleaning operations and documented the inspection on a QCIR that is referenced in the completed WP documentation. The data in the completed WPs included the required results.

Overall, Parsons has well defined processes for performing pressure testing and cleaning and flushing of piping without being overly complex. Personnel involved in the testing were knowledgeable about requirements. The SWPF pressure testing and flushing program is adequate in demonstrating that the facility pressure boundary components are leak tight and meet cleanliness requirements in a code compliant manner. All personnel involved give significant attention to personnel safety during testing, including physical proximity control/access limitations, restraint of test couplings, and tagging of test boundaries.

5.2 Review of the Startup Test Program

Criteria: Construction and pre-operational tests shall be conducted in accordance with methods approved by the design organization. Test procedures shall include test requirements, acceptance criteria, test prerequisites, inspection hold points, and instructions for recording data. Testing shall be observed by qualified inspection personnel. Test results shall be recorded and evaluated by qualified personnel. (NQA-1, Criterion 11; Section 11 of the SWPF QAP; and DOE Order 414.1C). Objective TP.01.01 of CRAD 31-05: *Verify site contractor line management has established a construction test program and procedures that ensure effective testing of structures, systems and components (SSC) relied upon to function or support the function of preliminary documented safety analysis (PDSA or DSA if approved) credited SSC.*

5.2.1 Startup Testing Program Requisites

P-SUP-J-00001, Commissioning Plan, April 25, 2011, fulfils Deliverable 5.1 for Contract No. DE-AC09-02SR22210 and describes the commissioning and testing phase following construction turnover. This commissioning plan describes the scope of startup testing including startup test plans and procedures;

conduct of startup testing; calibration, grooming, and alignment (CG&A) component tests; system operational tests (SOTs); integrated system operational tests (ISOTs); approval of test results; maintenance trials; and laboratory instrumentation testing. Some of the descriptions in the original plan contained placeholders stating "to be determined" (TBD). Additional processes and procedures have continued to develop and mature since P-SUP-J-00001 was approved. Consequently, some TBDs are out of date. (See **OFI-SWPF-02**.)

The SWPF SOT program is described in PL-CM-8010, *SWPF SOT Plan*. This document lays out the plan for preparing SOT procedures developed in accordance with PP-CM-8102, *Startup Test Procedure Administration,* and DP-CM-8012, *Additional Guidance on SOT/ISOT Procedure Development*. SOT procedures are developed on the provided standardized *SOT/ISOT Layout* or template that is updated to include lessons learned from prior review and comment cycles. These SOT/ISOT procedures work in conjunction with CGA-PLN-001, *SWPF Calibration, Grooming, and Alignment (CG&A) Plan,* to provide final system reports for completing the commissioning phase. The full scope of SOTs covers approximately 60 systems, all of which were in construction status at the time of this review. SWPF Commissioning is developing the SOTs before commissioning and testing phase and plans to revise each SOT to incorporate any changes that have occurred to design and installation that effect system testing. Each SOT has a comprehensive listing of drawings and references that will be verified to ensure the revision captures all relevant changes. The Attribute Verification Database (AVD) identifies specific testable attributes for each system.

The AVD is defined in PL-EN-5002, *SWPF Function Performance Verification Plan,* and is controlled by procedure PP-EN-5027, *Attribute Verification Database Procedure*. The AVD defines the acceptance criteria and notes any comments applicable to the test. Although more attributes are planned to be tested than identified with an AVD, the AVD includes all safety significant (SS) testable features (e.g., interlocks and alarms), select control sequences where additional test requirements or data acquisition is required, required system performance parameters, and other testable features specified by Engineering. AVD attributes related to the specific systems and SOTs reviewed by EA are discussed below.

The scope of testing defined in some SOTs is more focused than originally intended. SWPF Contract deliverable 5.1.e states in part, "System Operational Tests (SOTs) will establish the performance baseline for each system for comparison to the design requirements." The definition of *System Operational Test* in procedure PP-CM-8102, *Startup Test Procedure Administration,* is consistent with the contract performance expectations. PP-CM-8102 states, "SOTs are designed to functionally and simultaneously test all equipment and components within the test boundaries including to the extent possible, the associated control system. Typically SOTs will align the system to perform in a normal operational mode and demonstrate that the system can operate to its designed parameters, including a verification of all control sequences. SOTs sometimes also verify the ability of a system to perform as designed under upset or off-normal modes." However, the description of SOTs in supporting procedure DP-CM-8012, *Additional Guidance on SOT/ISOT Procedure Development*, and as demonstrated in the reviewed SOTs, does not meet the level of testing that achieves the PP-CM-8102 defined performance baseline. That baseline is more accurately encompassed by ISOTs with additional testing (such as the integrated water runs) that follow ISOTs. The SOTs as currently scoped perform component-level operability testing such as tank volume-to-level mapping, flow paths, functional testing of interlocks, alarms, control loops, pumps, sumps and p-traps, and flow element and transmitter testing. The performance baseline developed with the current scope of SOTs is a component-level functionality test, not a functional system test. Regardless of this point, the overall scope of testing accomplishes the goals of the commissioning testing program. An overall test plan that demonstrates that all the component and systems are appropriately tested in a planned sequence would be helpful to demonstrate that no gaps exist. Parsons has no plans to develop an overall test plan sequence beyond the logic that support systems must be tested first and be available for later tests. (See **OFI-SWPF-03**.)

5.2.2 Training

PL-TR-1801, *Personnel Selection, Training, and Qualification Plan,* outlines the overall SWPF project training scope. The details relevant to the test engineers are contained in procedure DP-CM-8200, *Test Engineer Qualification,* which is based upon meeting NQA-1, Appendix 2A-1, *Nonmandatory Guidance on the Qualifications of Inspection and Test Personnel*.

The Parsons training group developed a qualification card and qualified existing test engineers in 2012. Parsons has reviewed the performance of the test engineers annually since qualification. Test engineer qualifications for the SOTs under consideration conform to the existing training commitments. The training group is currently performing a job-task-analysis of the current testing procedures and guidance. This review includes a comprehensive task-to-training analysis to develop a more detailed qualification card and training requirements. This in-progress draft effort is a significant improvement over the existing qualification program. Parsons is completing this analysis to ensure their training program fully complies with the technical staff training requirements of DOE Order 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities.*

Procedure DP-CM-8200, *Test Engineer Qualification,* does not reflect current positions and responsibilities. For example, the procedure assigns responsibilities to the Testing Engineer Supervisor although the position does not exist in the current Parsons' organization chart and the responsibilities are currently being fulfilled by the Test Engineering Manager. (See **OFI-SWPF-04**.)

5.2.3 Other Programmatic Observations

PL-AS-1001, *SWPF Integrated Assessment Program Plan,* describes a reasonably comprehensive approach to assessment planning. PL-AS-1001 does not reflect the current versions of DOE Orders specified in Contract DE-AC09-02SR22210 (e.g., DOE O 426.2 Personnel Selection, Training, Qualification and Certification Requirements for DOE Nuclear Facilities, DOE O 422.1 Conduct of Operations). Appendix B is missing other required assessments such as 10 CFR 835 Occupational Radiation Protection – specifically 835.102 internal audits. (See **OFI-SWPF-05**.)

The proper interpretation of how to implement procedure PP-CM-8019, *Conduct of SOT/ISOT Testing*, procedure section 2.9, Test Restart, step [2], which states "Pre-requisites must be re-verified prior to TEST RESTART if STOP TEST has been in effect for more than one work shift", and a similar statement in Section 2.5, step [5] is confusing. Based on discussion with Parsons' management, the intent of the procedural steps was to require re-verification of prerequisites if one or more work shift changes has occurred after a test is stopped in progress. (See **OFI-SWPF-06**.)

The maintenance activities authorized during testing in procedure PP-CM-8019, *Conduct of SOT/ISOT Testing*, procedure section 2.11, Troubleshooting, lack sufficient controls to prevent unintended and unrecognized invalidation of earlier test results. In addition to troubleshooting activities that are unlikely to invalidate earlier test results, the procedure authorizes activities, such as replacing filters, adding lubrication, tightening threaded fittings or other components, adjusting packing, lifting/landing leads, and performing CG&A, without additional controls on the consequences. (See **OFI-SWPF-06**.)

5.2.4 Development of SOTs

Criteria: Construction and pre-operational tests shall be conducted in accordance with methods approved by the design organization. Test procedures shall include test requirements, acceptance criteria, test prerequisites, inspection hold points, and instructions for recording data. Test results shall be recorded and evaluated by qualified personnel. (NQA-1, Criterion 11; Section 11 of the SWPF QAP;

and DOE Order 414.1C). Objective TP.01.02 of CRAD 31-05: *Verify startup test procedures accomplish the testing objectives and are consistent with the contractor's technical and administrative criteria, PDSA commitments, design documents, design control database (DCD), regulatory requirements, and Technical Specification Requirements (TSR).* Objective TP.02.02 of CRAD 31-05: *Review of Startup Test Procedures. Verify that a test procedure exists for each element of the approved test plan. For the tests selected, review the startup test procedures and the additional requirements for the respective test.*

The SWPF Commissioning and Testing group has established a PP covering the programmatic requirements for developing, reviewing, approving, and changing the startup test procedures performed during the startup testing and cold commissioning phases of the project. Procedure PP-CM-8102, *Startup Test Procedure Administration,* Revision 2, describes the program for developing SOT and ISOT and integrated water runs testing phase procedures. This document outlines the content and other guidance for procedure preparation. Qualified test engineers are to use the detailed guidance discussed below to prepare the procedures.

This PP is augmented by the more detailed departmental procedure DP-CM-8012, *Additional Guidance on SOT/ISOT Procedure Development.* This procedure provides detailed guidance for developing SOT/ ISOT procedures including content, format, writing style, and SWPF-specific features for the procedures. A template that incorporates lessons learned from previous test procedure development is maintained for new procedures. These guidance procedures were generally consistent with the Parsons V-SCD-J-00002, *Procedure Writer's Guide*.

The procedure development and approval process includes a review and approval by the multidiscipline Joint Test Group (JTG), as specified in procedure PP-CM-8107, *Joint Test Group,* and final approval by the senior level Commissioning Review Board (CRB), as specified in procedure PP-CM-8018, *Commissioning Review Board*. Parsons chartered these committees for the JTG to ensure that comments developed through detailed procedure review are appropriately dispositioned and test results are reviewed and for the CRB to ensure that contract required responsibilities are discharged for approval of designated detailed plans, procedures, review of testing issues, commissioning progress, and results requiring review. The membership for the JTG includes the Nuclear Safety Manager when SS SSC testing is under review, although the Nuclear Safety Manager is not a quorum member. EA observed one JTG meeting. The JTG demonstrated proper quorum requirements for the JTG review. Further, CRB approval was verified by EA for the SOTs reviewed.

It is difficult to ascertain from the Commissioning and Test Plan that all components receive the necessary testing. A database is being built that identifies the components (e.g., valves) that are part of each construction turnover system, but these do not correlate directly to the SOT scope. EA reviewed the following SOTs.

5.2.4.1 Salt Solution Feed SOT-SSF-001. EA identified the following deficiencies with this SOT:

- Prerequisites in Section 5 do not include approvals such as acceptance of the system from construction or how open punch list items are addressed. (See **OFI-SWPF-07**.)

- Section 5.3, *Utilities*, does not include the Pulse Mixer Ventilation System, which is used as motive force for air pulse agitators (APAs) in the lift/drop low mode. (See **OFI-SWPF-07**.)

- Tank level mapping of TK-109 goes only to the top of the solvent weir instead of to the overflow. Testing the overflow is difficult because there is no isolation valve in the weir line to TK-208. The system operating procedure does not require flow path verification on the

overflow line. The weir line is 2" and the overflow is 6", the size required to prevent pumps from pressurizing the tank. (See **OFI-SWPF-07**.)

- Step 6.5.47 leaves TK-109 full to the solvent weir, but this level is not verified before starting the pumps in later steps; Step 6.8 and 6.10 conduct performance check-out of Pumps P-109A and 109B. The Engineering Memorandum requires Test 2 testing. Test 2 includes "Perform visual \ auditory check." Appendices 7 and 8 do not make provision for recording a visual check or "available hydraulic data." The column labeled, "Actual Flow (gallons per minute) from Faceplate" contains expected (acceptance) values. No special action is noted for not meeting the flow acceptance criteria. Sound level reading is required to be taken at 1 meter, but the radial location is not specified or recorded. The intent of the visual/auditory check is not specified. Data collected may not be as intended or repeatable and useful for evaluating performance changes from this baseline. (See **OFI-SWPF-07**.)

- A note on Appendix 7 and 8 states, "Any reading not obtained is to be marked N/A." However, this note does not include a statement about recording a justification in the test log why a reading was not obtained. (See **OFI-SWPF-07**.)

- Step 6.9 tests features associated with loss of Barrier Fluid Tank pressure for pump 109A. A note before step 6.9.4 states, "NOTE: The following step will cause a low alarm, low-low alarm, and interlock PDIC-2823LL." Subsequent steps record actuation of the low-low alarm and PDIC interlock to trip the pump, but not actuation of the low alarm. Parsons did not provide a justification for omitting the recording of the low alarm actuation. (See **OFI-SWPF-07**.)

- Step 6.12 of *AGT-109 APA Lift/Drop Low Operation (Part of Attribute No. 1040)* performs partial testing of Attribute 1040 *Tank 109 Air Pulse Agitator (APA) Mixing:* (1) Description: "Verify logic and operation of equipment and instrumentation associated with the mixing of Tank 109 based upon the level in tank, and (2) Acceptance Criteria: verify equipment operates per control logic sequence to mix Tank 109 based upon the level in tank." The testing planned verifies the logic sequence, but does not verify that the equipment operates for Tank 109 in the lift/drop low mode. (See **OFI-SWPF-07**.)

- M-SD-J-00004, R0 SWPF System Description Heating Ventilating, and Air Conditioning, states that the Pulse Mixer Ventilation System (PMVS) is not credited in the DSA. Although it is not credited as a safety system, the PMVS provides a vacuum (the motive force for gravity drop) for the APA operation in the lift/drop mode used during low tank level operation. The PMVS is not specified as a prerequisite to the SOT and is isolated for the APA test. The contractor should consider testing this operating mode functionality. (See **OFI-SWPF-07**.)

- The SOT does not require a record verifying that all system valves inside the boundary operate properly (some are manual reach-rod operated). (See **OFI-SWPF-07**.)

- SOT procedures (Section 6) start with system lineups. No guidance is provided for how long these lineups are good – i.e., when to verify lineups during extended testing periods (e.g., repair delays). (See **OFI-SWPF-08**.)

5.2.4.2 Caustic Wash Tank SOT-CWT-001. EA identified no concerns with this SOT procedure except for previously identified concerns that the test prerequisites in Section 5 do not include approvals such as acceptance of the system from construction and procedures (Section 6) start with system lineups as noted in **OFI-SWPF-07** and **OFI-SWPF-08.**

5.2.4.3 Standby Diesel Generator, SOT-SDG-001, Rev.0. The purpose of this SOT is to test the in-service standby diesel generator (SDG) system. The stated scope of this system includes the diesel generator; the fuel storage and supply systems; the load bank and associated cooling systems; and the Automatic Transfer Switches (ATSs) ATS-203 and ATS-204, along with associated wiring. The procedure states that the following testing attributes from the AVD are tested in this SOT:

- Attribute No. 783 - Transfer of Electrical Load to SDG System
- Attribute No. 987 - Load Sequencing for the SDG
- Attribute No. 989 - SDG Trouble Alarm
- Attribute No. 990 - Diesel Generator Load Bank Test.

SOT-SDG-001 does not list E-SD-J-00002, Rev. B, *SWPF System Description Electrical,* as a referenced document. This system description is out of date and some of the included information has been superseded. For example, the system description states that ATS-205 will start the SDG if it senses a loss of power. Parsons test engineers stated that Design Engineering later determined that the SDG start feature of ATS-205 was not required. Design Engineering issued Design Change Notice 1227, *Update of Electrical Schematic Drawings*, to delete the schematic showing ATS-205 was connected to a DG Start Control Circuit. Design Engineering stated that only ATS-203 and 204 SDG start signal wires were landed in the SDG controls and the diesel generator supplier will provide the drawings to document that fact.

Interoffice Correspondence, 00-700-18804, Rev. 2, *Engineering Approach to Additional Testing of Systems and Components for SWPF,* states that all interlocks will be tested for functionality in the startup test procedures developed by the Commissioning and Test group. SS interlocks are documented in the AVD; however, non-SS interlocks are not, and the SOTs are principally focused on verifying AVD attributes. The SWPF electrical design includes a connection for a portable generator for use if the SDG is not available. The portable generator connection includes an installed output breaker with a non-SS interlock that is designed to prevent simultaneous closure of the SDG and portable generator breakers. Simultaneous closure of the SDG and portable generator output breakers could result in catastrophic electrical failures. Contrary to Interoffice Correspondence, 00-700-18804, Rev. 2, the SDG SOT does not include or require functional testing of this interlock. Parsons test engineers could not produce plans for or records of testing of this interlock and stated that Parsons does not intend to include this interlock in the scope of this SOT. (See **OFI-SWPF-09**.)

Procedure PP-CM-8102, Rev. 2, *Startup Test Procedure Administration*, Section 3.0, step [7] states "SOTs are designed to functionally and simultaneously test all equipment and components within the test boundaries including to the extent possible, the associated control system." SOT-SDG-001 does not include verification of the normal power conditions necessary to initiate SDG starting nor the timing, sequence, and conditions that must be met for loads to be transferred from normal power to the SDG following loss of the normal feeds to either ATS-203 and/or ATS-204. Specification 16415, *Automatic Transfer Switches*, section 2.2.3, states:

1. The automatic transfer switch shall be arranged to close and/or open pilot contacts for automatic remote starting of the engine-driven generator within 10 seconds after normal-source failure or within 10 seconds after a drop in voltage on any phase to 85 percent or less.
2. The load circuits shall not be disconnected from the normal source during the 10-second time delay period.
3. When the standby generator is delivering at least 95 percent of rated voltage and frequency, the load circuit shall be transferred after a time delay adjustable from 0 to 60 seconds.

The SOT does not test the functions of ATS-203 and ATS-204 to verify that the ATSs perform in accordance with the specified requirements. (See **OFI-SWPF-09**.)

The cognizant system engineer raised similar issues on March 20, 2014. The JTG records document the following question from the cognizant system engineer: "Have all the time delays provided by the ATSs (i.e., Feature 1C-normal source failure to engine start; 2B-transfer to emergency on availability of emergency sources; 1F-emergency source failure retransfer (normal source available); 2E-engine cool down following retransfer to normal; 3A-retransfer to normal (normal failure mode); 3A-retransfer to normal (test mode)) been considered for performing this testing?" The Parsons Engineering disposition of the cognizant system engineer question was a documented commitment for "Delays will be added, as appropriate" without listing specifics. (See **OFI-SWPF-09**.)

The DOE Comment Sheet prior to the March 24, 2014, JTG meeting also documented a concern that "This test will not record the necessary data to verify correct load sequencing as specified in AVD 987." The Parsons Engineering disposition was to not concur based on the fact that AVD 987 was being revised. The March 24, 2014, JTG meeting minutes documented a recommendation for SOT approval to the CRB and established action requirements for additional specified SOT edits and comments before the end of March. The July 3, 2014, CRB meeting minutes documented approval of the SOT without including the necessary data to verify correct load sequencing as specified in AVD 987.

The SOT also does not include verification that SDG loads will be transferred instantaneously to the ATS normal feeds on loss of the SDG. Specification 16415, *Automatic Transfer Switches*, section 2.2.4 states "If the generator should fail while carrying the load, retransfer to normal shall be made instantaneously upon restoration of the normal source." (See **OFI-SWPF-09**.)

Document P-SUP-J-00001, *Commissioning Plan*, Section 1.1, states that system operational testing will demonstrate the overall ability of plant systems to meet their intended performance and functional requirements. The SOT-SDG-001 as currently written is not acceptable to demonstrate that the SDG system will meet its intended design function. (See **OFI-SWPF-09**.)

5.2.4.4 Instrument Control Panels, SOT-ICP-001, Rev. 0. The purpose of this SOT is to test the instrument control panel (ICP) system, excluding panels associated with the safety instrumented system. The stated scope of the system to be tested includes ICP-1 through ICP-16 (except the three panels of the safety instrumented system), as well as the associated Fieldbus and DeviceNet cabling as indicated in Appendix 2 of SOT-ICP-001, *Verification of Foundation Fieldbus Cable Signal Integrity*, and Appendix 3 of SOT-ICP-001, *Verification of DeviceNet Cable Signal Integrity*. The procedure further indicates that "The following testing attributes from the Attribute Verification Database (AVD) are tested in this SOT:

- Attribute No. 909 - Fieldbus Data Quality Testing Test"

EA performed an in-depth review of the SOT procedural steps applicable to testing ICP-01 and ICP-04 to verify whether SOT requirements are adequate for testing ICP Fieldbus and DeviceNet segments. Testing requirements for these two ICPs were verified by EA to be representative of the remaining ICPs tested with this SOT. The SOT takes credit for previously performed tests, such as factory acceptance testing, site acceptance testing by the vendor, construction acceptance testing, software validation and verification, and other SOTs, without specifically listing them as prerequisites in SOT-ICP-001. Without a list of previously performed tests, no requirement in the SOT ensures all prerequisite tests are complete. (See **OFI-SWPF-10**)

Step 6.2.4 of SOT-ICP-001requires a resistance measurement, but does not list an acceptance criteria. Step 6.2.5 of SOT-ICP-001 specifies an acceptance criterion of 50,000 ohms, but references an incorrect step that has nothing to do with measuring electrical resistance. The assigned test engineer acknowledged these observations and indicated these errors had been identified earlier by Parsons.

Appendix 3 of SOT-ICP-001, *Verification of DeviceNet Cable Signal Integrity*, Page 585, NOTE 2, incorrectly directs testing using the Bushealth test mode for the Foundation Fieldbus. Further, Step 2.d on the same page incorrectly states "Highlight 'Foundation' in the list that appears," when it should state HIGHLIGHT "CAN" in the list. (See **OFI-SWPF-10**.)

Appendix 3 of SOT-ICP-001, page 589 of 591, Table 48, does not specify the required condition for the last two listed power supply circuit breakers. (See **OFI-SWPF-10**.)

The original engineering specified Performance Attribute Data Report, Attribute 909, *Fieldbus Data Quality Testing*, that was intended to establish the SOT testing acceptance criteria, required "Using a field bus monitor device, all fieldbus segments are tested for DC voltage level at the field device, LAS signal strength, and noise levels." Although Parsons Engineering and others originally approved AVD 909, Commissioning and Testing reversed their earlier approval on June 10, 2014, stating "The title, description and acceptance criteria are no longer applicable to the testing to be performed. This AVD entry needs to be re-written or deleted." The SOT was prematurely approved by the CRB in July 2014 before Parsons Engineering completed the necessary revisions to the AVD description and acceptance criteria reference that is the basis for the testing. AVD 909 was subsequently revised on November 5, 2014. (See **OFI-SWPF-10**.)

6.0 CONCLUSIONS

Overall, the construction quality at SWPF was adequate in the areas reviewed. Parsons has developed appropriate corrective actions to disposition closed NCRs. No deficiencies were identified while inspecting completed pipe supports. The process for installation of instrumentation and the program for pressure testing and cleaning and flushing of piping systems were adequate.

However, some of the SOTs that EA examined require additional review and revision to verify test acceptance criteria is appropriate, that testing methods demonstrate that equipment performs in accordance with design requirements and that systems are operable and perform as specified in the PDSA/DSA. Some test plan descriptions were out of date and had not been revised to incorporate design changes and the latest processes and procedures developed since start of construction. Training and qualification of test engineers was generally adequate. In one case, the senior level CRB reviewed and prematurely approved an SOT before concerns identified during the SOT review process were resolved.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified 10 OFIs. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are suggestions offered by the EA review team that may assist site management in implementing best practices, or provide potential solutions to minor issues identified during the conduct of the review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is anticipated that these OFIs will be evaluated by the responsible line management organizations and either accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

OFI-SWPF-01 Consider revising the pressure testing and cleaning and flushing procedures to require that each test plan document placement and removal of test boundary tags.

OFI-SWPF-02 Consider updating P-SUP-J-00001, *Commissioning Plan,* to include new or changed details.

OFI-SWPF-03 Consider developing an overall test plan sequence that goes beyond the logic that support systems must be tested first and be available for later tests.

OFI-SWPF-04 Consider revising Procedure DP-CM-8200, *Test Engineer Qualification*, to reflect current positions and responsibilities.

OFI-SWPF-05 Consider updating PL-AS-1001, SWPF Integrated Assessment Program Plan, to reflect the current versions of DOE Orders and regulatory assessment requirements specified in Contract DE-AC09-02SR22210.

OFI-SWPF-06 Consider revising procedure PP-CM-8019, *Conduct of SOT/ISOT Testing*, as follows:

- Revise Section 2.9, *Test Restart*, step [2] and Section 2.5, step [5]to clarify when re-verification of prerequisites is required if one or more work shift changes has occurred since an earlier STOP TEST.

- Revise Section 2.11, *Troubleshooting*, by adding a requirement that the test engineer review troubleshooting activities performed and the potential consequences to determine whether earlier parts of the test must be re-performed to ensure all the test results are valid for the as-left tested conditions.

OFI-SWPF-07 Revise SOT-SSF-001, *Salt Solution Feed*, as follows:

- Include acceptance of the system from Construction as a prerequisite in SOT-SSF-001.

- Revise Section 5.3, *Utilities*, to include the process vacuum system, which is used as motive force for APAs in the lift/drop low mode.

- Ensure testing of Tank TK-109 verifies the overflow capacity as a design feature required to prevent pumps from over-pressurizing the tank.

- Revise the SOT to include:
  - A verification of suction head/tank level before starting the pumps.
  - Provisions in Appendices 7 and 8 for recording a visual check or "available hydraulic data."
  - Actions for not meeting the flow acceptance criteria.
  - A method to record the radial location of the 1meter sound level readings.
  - The intent of the visual/auditory check.
- Revise the note on Appendices 7 and 8 to ensure that the test engineer records the justification in the test log (or elsewhere) for any notation of N/A.
- Revise Step 6.9 to include a record of the low alarm actuation.
- Evaluate whether Step 6.12, *AGT-109 APA Lift/Drop Low Operation* (Part of Attribute No. 1040), performs the partial testing of Attribute 1040 Tank 109 APA mixing.
- Ensure the PMVS is specified as a prerequisite for the entire SOT and not solely for the APA test.
- Provide a method to record verification that all system valves inside the boundary operate properly (some are manual reach-rod operated).

OFI-SWPF-08 Recommend that SOT procedures provide guidance as to how long the system lineups are reliable (during extended testing periods including repair delays).

OFI-SWPF-09 Consider revising SOT-SDG-001, *Standby Diesel Generator*, as follows:

- Require verification that the SDG output breaker will not close if the portable generator output breaker is shut, and the portable generator output breaker will not shut if the SDG breaker is shut, whether or not ATS-203 and/or ATS 204 attempts to start and load the SDG.
- Require verification of the operability of ATS-203 and ATS-204 to:
  - Start the SDG as designed with a specified time delay upon detecting specified degraded normal power voltage or frequency condition.
  - Delay disconnecting ATS load circuits from the normal source during a specified time delay period.
  - Transfer ATS load circuits to the SDG after a specified time delay when the SDG is delivering at least 95 percent of rated voltage and frequency.

- Require verification that SDG loads transfer instantaneously as designed to the ATS normal feeds on loss of the SDG.

OFI-SWPF-10 Consider revising the ICP SOT as follows:

- Revise the prerequisites to specifically list and include confirmation of satisfactory completion of factory acceptance testing, site acceptance testing by the vendor, construction acceptance testing, CG&A, software validation and verification, or other SOTs that must be prerequisites before the SOT can be implemented as written.

- Revise Appendix 3, page 589 of 591, Table 48, to specify the required condition for the last two listed power supply circuit breakers.

- Formally review and document approval of the ICP SOT against the test requirements of the new AVD 909, including JTG and CRB review, comment resolution, and approval.

8.0 ITEMS FOR FOLLOW-UP

EA will continue to follow up and inspect pipe supports and instrumentation systems and continue to review the results of pressure testing and cleaning and flushing activities performed on piping systems. EA will also continue to review the startup testing program to verify startup testing adequately demonstrates that equipment and systems meet design requirements and that systems perform as required to meet SWPF operational requirements and expectations.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: November 3–7, 2014

Office of Enterprise Assessments Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environmental, Safety, and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments

Quality Review Board

William A. Eckroade
Thomas R. Staker
William E. Miller
Patricia Williams
Karen L. Boardman
T. Clay Messer
Michael A. Kilpatrick

Office of Enterprise Assessments Site Lead for Savannah River Site

Phillip D. Aiken

Office of Enterprise Assessments Team Composition

Phillip D. Aiken, Lead
Joseph J. Lenahan
Charles R. Allen
Eric R. Swanson
T. Timothy Martin

Appendix B
Key Documents Reviewed, Interviews, and Observations

Key Documents Reviewed

- Procedure DP-CS-7319, Rev. 5, Leak Test of Process Piping, October 6, 2014
- Procedure DP-CS-7321, Rev. 1, Flushing/Cleaning of Process Piping, September 30, 2014
- Procedure DP-CS-7322, Rev. 1, Foreign Material Exclusion, July 30, 2013
- Procedure DP-CS-7323, Rev. 1, Leak Testing and Flushing Prerequisites, March 8, 2013
- Procedure DP-QC-4801, Rev. 2, Quality Control Inspector Certification, March 18, 2011
- Procedure DP-CS-7324, Rev. 0, Piping System Completion Verification, April 11, 2013
- Procedure PP-QC-4802, Rev. 6, Quality Control Inspection, September 19, 2013
- Procedure PP-QA-4701, Rev. 5, Surveillance Program, February 22, 2010
- Procedure PP-QA-4703, Rev. 15, Nonconforming Items, October 6, 2014
- Procedure PP-QA-4711, Rev. 4, Control of Measuring and Test Equipment, October 2, 2013
- Procedure PP-AS-1203, Rev. 8, Corrective Action Program, November 5, 2012
- Procedure DI-CS-020, Rev. 0, Pneumatic Test Exclusion Area and Static Head Correction Factor Determination, February 20, 2013
- Procedure DI-CS-016, Rev. 0, Instrument Tubing Blowdown and Leak Test, November 8, 2010
- Procedure DI-CS-019, Rev. 2, Sampling and Analysis Instructions for Piping Hydrostatic Test and Flushing, February 13, 2013
- Procedure DI-QC-004, Rev. 1, Functional Check of Pressures Gauges, January 24, 2013
- ITP Number ITP-05120-0001, Rev. 3, Section 05120, Structural Steel (Pipe Supports), July 11, 2014
- ITP Number ITP-05120-0002, Rev. 0, Section 05120, Structural Steel (Anchorage for SS/PC-1, SS/PC-3 and GS/PC-3 Equipment), July 3, 2013
- ITP Number ITP-15112-0001, Rev. 3, Section 15112, Pipe Leak Testing, (Process Piping), March 28, 2013
- ITP Number ITP-15121-0002, Rev. 3, Section 15121, Field Inspection of Process Piping, March 28, 2013
- Document Number PL-QC-4800, Rev. 0, Quality Control Inspector Qualification/Certification Plan, March 15, 2010
- Document Number PL-CS-7205, Rev. 0, Process Pipe Flush Plan, October 7, 2011
- Specification Section 15060, Rev. 1, Hangers and Supports, September 20, 2010
- Specification Section 15112, Rev. 13, Pipe Leak Testing, August 8, 2014
- Specification Section 15121, Rev.18, Installation of Process Piping, September 15, 2014
- Specification Section 16910, Rev.12, Instrument Equipment Installation, October 15, 2014
- SWPF Piping Isometric Drawing numbers P-PI-J-02-0582-01, Rev. 0; P-PI-J-02-4563-01, Rev. 5; P-PI-J-02-6059-01, Rev. 2; P-PI-J-02-6425-01, Rev. 4; P-PI-J-02-6427-01, Rev. 7; and P-PI-J-02-7951-01, Rev. 5
- SWPF Standard and Special Pipe Support Drawing numbers P-CH-J-0044, Rev. 13; P-CH-J-0045, Rev. 5; P-CH-J-0070, Rev. 14; P-CH-J-0072, Rev. 2; P-CH-J-0076, Rev. 2; P-CH-J-0080, Rev. 7; P-CH-J-0090, Rev. 4; P-CH-J-0101, Rev. 11; P-CH-J-0528, Rev. 0; P-CH-J-0531, Rev. 0; P-CH-J-0649, Rev. 2
- Drawing Number J-JB-J-00102, Instrument Installation Detail, Typical Tube Support, Sheets 1 through 10, Rev. 1, August 11, 2014, and Sheet 11, Rev. 0, August 6, 2014
- SWPF Preliminary Documented Safety Analysis, Document Number S-SAR-J-00001, dated September, 30, 2008

- Non Conformance Report numbers 1050 through 1072, 1074 through 1082, 1084, 1185, 1187 through 1139, 1141 through 1143, and 1146 through 1148. The following numbers were not issued or were invalidated: 1073, 1083, 1086 1140, 1144, and1145
- Parsons Document number V-QP-J-00001, Rev. 5, SWPF Quality Assurance Plan, January 22, 2013
- Specification Section 15940, Rev. 1, HVAC Sequence of Operation, December 19, 2011
- Specification Section 16231, Rev. 3, Standby Diesel Generator Package, September 19, 2013
- Specification Section 16415, Rev. 2, Automatic Transfer Switches, September 19, 2013
- Specification Section 16965, Rev. 1, Electrical Acceptance and System Function Tests, October 10, 2012
- PL-CM-8007, *Distributed Control System / Instrumentation and Controls Project Plan*, October 15, 2012
- PL-CM-8010, Rev. 0, SWPF SOT Plan
- PL-TR-1801, Personnel Selection, Training, and Qualification Plan
- PL-EN-5002, Rev. 0, SWPF Functional Performance Verification Plan, October 5, 2010
- PL-EN-5004, *SWPF Design Requirements Verification Plan*, May 18, 2011
- P L-MN-8709, Rev. 0, Work Control Program Plan, June 6, 2014
- PP-CM-8018, Rev. 4, Commissioning Review Board, September 5, 2014
- PP-CM-8019, Rev. 1, Conduct of SOT/ISOT Testing
- PP-CM-8102, Rev. 2, Startup Test Procedure Administration, September 8, 2014
- PP-CM-8103 *SWPF System Turnover from Construction to Commissioning*, May 23, 2014
- PP-CM-8104, *Turnover Punch List Item Processing*, October 31, 2014
- PP-CM-8107, Rev. 6, Joint Test Group, September 5, 2014
- PP-EN-5027, Rev. 3, Attribute Verification Database Procedure, April 15, 2014
- PP-MN-8714, Rev. 0, CHG-1, Working on or Near Energized Electrical Equipment
- PP-MN-8714, Rev. 0, Working On or Near Energized Electrical Equipment
- DP-CM-8001, *Conduct of Testing*, October 18, 2013
- DP-CM-8007, *Control of Work at PTC*, April 26, 2012
- DP-CM-8010, *Test Results Review and Approval*, September 8, 2014
- DP-CM-8012, Rev. 4, Additional Guidance on SOT-ISOT Procedure Development
- DP-CM-8200, Rev. 2, Test Engineer Qualification
- DP-EN-5024, *BPCS Software Testing and Verification Guide*, April 9, 2014
- P-SUP-J-00001, Rev. 0, Commissioning Plan
- S-CIP-J-00006, Rev. 2, Integrated Construction And Acceptance Testing Program
- 00-700-18804, Rev. 2, Engineering Approach to Additional Testing of Systems and Components for SWPF
- 00-700-20513, Standby Diesel Generator Indication Requirements for the Distributed Control System
- CGA-PLN-001, Rev. 0, SWPF Calibration, Grooming, and Alignment (CG&A) Plan
- DCN-1227, Rev. 0, Update Electrical Schematic Drawings (Part1)
- DeltaV Books Online Section 2, Hardware Installation, Appendix A, Fieldbus Segment Checkout
- DRAFT White Paper, The Impact of the DeltaV Control System Structure and Programming on SWPF System Operational Tests (SOTs)
- E-E2-J-0004, Single Line Diagram, SWGR-203 & 204
- E-E2-J-0005, Single Line Diagram, 480V DG-201 & SWGR-205
- E-E2-J-0008, Single Line Diagram, 480V MCC-203
- E-E2-J-0009, Single Line Diag, 480V MCC-204
- E-E2-J-0016, Single Line Diag, 480V USX-301
- E-E4-J-00433, SWPF Process Building Electrical Facility Support Area Schematic, ATS-205
- E-SD-J-00002, Rev. B, Electrical

- Fieldbus Foundation System Engineering Guidelines, Rev. 3.2.1
- IDR Status Sheet for SWPF SOTs dated 9/30/2014
- J-J8-J-00037, Rev. 2, SWPF Instrumentation Segment Diagram, FF-01C3S4A
- J-J8-J-00201, Rev. 1, SWPF Instrumentation Segment Diagram, DN-04C4S5
- J-JS-J-00102, ICP-01 Cabinet Layout, Sheet 2
- J-JS-J-00400 & 00401, Rev. 1, SWPF Instrument Control Panel ICP-04, Cabinet Layout, Sh 1 & 2
- J-JS-J-00402, Rev. 3, SWPF Instrument Control Panel ICP-04, BOM and Nameplate Schedule
- J-JS-J-00403, Rev. 1, SWPF Instrument Control Panel ICP-04, Terminal Strip Details
- J-JS-J-00404, Rev. 1, SWPF Instrument Control Panel ICP-04, Carrier and Card Layout
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- Performance Attribute Data Report, Attribute 987, Rev. 0, Load Sequencing for the Standby Diesel Generator (SDG)
- Performance Attribute Data Report, Attribute 989, Rev. 0, Standby Diesel Generator Trouble Alarm
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- Attribute No. 909 - *Fieldbus Data Quality Testing*, November 5, 2014
- Attribute No. 987 - *Load Sequencing for the SDG*, May 21, 2014
- Attribute No. 989 - *SDG Trouble Alarm*, May 21, 2014
- Attribute No. 990 - *Diesel Generator Load Bank Test*, May 21, 2014
- Attribute No. 1040 - *Tank 109 Air Pulse Agitator (APA) Mixing*, September 3, 2014.

Interviews

- Director of Construction
- Director of Engineering
- Deputy Director of Engineering
- Construction Manager
- Commissioning and Testing Manager
- Test Operations Manager
- Test Engineering Lead
- SDG Test Engineer
- ICP Test Engineer
- DCS Software System Engineer
- Pressure Test Engineers
- Field Engineers
- QC Manager
- QC Inspectors
- QA Manager

Observations

- Hydrostatic test and cleaning and flushing of a spool piece in WP 0918.
- Cleaning and flushing of four drain lines installed to discharge potentially radioactive liquid waste from the laboratory glove boxes in WP 0725.
- A sample of installed instrument lines, various locations in the CPA.
- Pipe supports at locations A on Isometric Drawing number P-PI-J-02-0582-01, Rev. 0; locations A, B, C, D, and E on Isometric Drawing number P-PI-J-02-4563-01, Rev. 5; locations A, B, and C on Isometric Drawing number P-PI-J-02-6059-01, Rev. 2; locations A, B, C, and D on Isometric Drawing number P-PI-J-02-6425-01, Rev. 4; locations A, B, C, and D on Isometric Drawing number P-PI-J-02-6427-01, Rev. 7; and locations A, B, C, D, E, and H on Isometric Drawing number P-PI-J-02-7951-01, Rev. 5.