Office of Enterprise Assessments Targeted Assessment of the Hanford Site Tank Farms Low Activity Waste Pretreatment System Preliminary Safety Design Basis

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Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
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Table of Contents

Acronyms

AC	Administrative Control
CD	Critical Decision
CFR	Code of Federal Regulations
COA	Condition of Approval
CRAD	Criteria and Review Approach Document
CSER	Criticality Safety Evaluation Report
DiD	Defense-in-Depth
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
FHA	Fire Hazards Analysis
IX	Ion Exchange
LAWPS	Low Activity Waste Pretreatment System
MAR	Material-at-risk
OFI	Opportunity for Improvement
ORP	DOE Office of River Protection
PDSA	Preliminary Documented Safety Analysis
PrHA	Process Hazard Analysis
PSDR	Preliminary Safety Design Report
PSVR	Preliminary Safety Validation Report
SAC	Specific Administrative Control
SBRT	Safety Basis Review Team
SSC	Structure, System, and Component
STES	Standby Tank Exhaust System
TSR	Technical Safety Requirement
WRPS	Washington River Protection Solutions

Office of Enterprise Assessments
Targeted Assessment of the Hanford Site Tank Farms
Low Activity Waste Pretreatment System
Preliminary Safety Design Basis

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted a targeted assessment of the Preliminary Safety Design Report (PSDR) and Preliminary Safety Validation Report (PSVR) for the High-Level Waste Tank Farms Low Activity Waste Pretreatment System (LAWPS) at the Hanford Site. This targeted assessment of the PSDR and PSVR focused on select aspects of the LAWPS processes, hazards, and controls for conformance to the requirements of DOE-STD-1189-2008, *Integration of Safety into the Design Process*, and DOE Order 420.1C, *Facility Safety*. This assessment is part of a series of targeted safety basis assessments of nuclear facility construction projects at selected DOE sites.

The PSDR assessment addressed the development, review, and approval of the LAWPS safety design documents. Specifically, EA sampled the most significant hazard events and associated control strategies. Overall, the PSDR adequately addresses the requirements of DOE-STD-1189-2008 and DOE Order 420.1C, and adequately supports the progression of the LAWPS safety design basis.

The PSDR summarizes a thorough hazard analysis, which is supported by an appropriately comprehensive process hazard analysis. The consequence analyses used to support the hazard analysis and control selection are suitably conservative, and appropriately conclude that no public radiological or chemical exposure guidelines are challenged and no safety class controls are required. Consistent with the logic in the hazard analysis, the PSDR appropriately designates safety significant structures, systems, and components (SSCs) for the protection of the co-located and facility workers. The safety strategy appropriately relies on multiple physical barriers, including piping, vessels, and underground vaults and pits, to confine hazardous substances, and interlocks to control hazards such as flammable gas events and direct radiation exposures. The PSDR safety strategy properly incorporates defense-in-depth controls.

For the selected safety significant SSCs, the PSDR safety functions, functional classifications, functional requirements, performance criteria, and design requirements are generally appropriate. The PSDR appropriately integrates the supporting hazard analyses with the nuclear safety design and is consistent with the hierarchy of controls in DOE Order 420.1C. The system descriptions reflect the current level of preliminary systems-level design (i.e., 60%) maturity.

During the assessment, EA identified several discrepancies in the draft PSDR. Subsequent interactions with the LAWPS project team resulted in resolution of all EA comments, including 24 comments that are closed pending verification of resolution in the preliminary documented safety analysis.

The DOE Office of River Protection Safety Basis Review Team (SBRT), which included individuals with appropriate subject matter expertise, documented their review of the PSDR in a PSVR. Overall, the PSVR addresses the DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, approval bases; includes sufficient discussion of the modifications to the design resulting from the resolution of the SBRT comments identified during the review; and appropriately concludes that the PSDR supports proceeding to the final design phase.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted a targeted assessment of the High-Level Waste Tank Farms Preliminary Safety Design Report (PSDR) and Preliminary Safety Validation Report (PSVR) for the Low Activity Waste Pretreatment System (LAWPS) at the Hanford Site. The targeted assessment evaluated the current LAWPS preliminary safety design basis and select supporting preliminary design media and calculations. This assessment, which was performed in part at the Hanford Site from July 10 - 20, 2017, is part of a series of targeted safety basis assessments of nuclear facility construction projects at selected DOE sites.

2.0 SCOPE

This assessment covered the development of the LAWPS preliminary safety design basis, which consisted of the PSDR and supporting documents, such as the LAWPS Safety Control Development and Design Integration report and the fire hazards analysis (FHA). The assessment also included an evaluation of the review and approval of the PSDR by the DOE Office of River Protection (ORP).

3.0 BACKGROUND

Washington River Protection Solutions (WRPS), the management and operating contractor for Hanford Site Tank Farms, is designing and constructing the LAWPS. ORP provides management and oversight of the project for the DOE Office of Environmental Management. The ORP Manager is the Safety Basis Approval Authority.

The LAWPS project team is implementing the requirements and processes established in DOE Order 420.1C, *Facility Safety*, and DOE-STD-1189-2008, *Integration of Safety into the Design Process*, for the development, review, and approval of the facility's preliminary safety design basis. The PSDR, PSVR, and supporting analyses collectively comprise the LAWPS preliminary safety design basis.

The LAWPS project team submitted the draft PSDR for ORP review on May 25, 2017. ORP provided comments to the LAWPS project team during June and July. During August, the LAWPS project team resolved ORP comments by either incorporating them in the PSDR or earmarking them for incorporation in the Preliminary Documented Safety Analysis (PDSA). The LAWPS project team submitted PSDR revision 0A for ORP approval on August 14, 2017. ORP issued the PSVR on September 21, 2017, and the approved PSDR revision 0 was issued on October 26, 2017.

4.0 METHODOLOGY

DOE Order 227.1A, *Independent Oversight Program*, describes and governs the DOE independent oversight program. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement (OFIs)" as defined in DOE Order 227.1A. In this report, less significant issues that, if left unresolved, can potentially rise to a deficient condition are defined as "discrepancies."

As identified in the approved EA plan (*Plan for the Office of Enterprise Assessments Targeted Review of the Hanford Site Low Activity Waste Pretreatment System Preliminary Safety Basis*, October 2015), this targeted assessment considered requirements for the LAWPS preliminary safety design basis documents from DOE Order 420.1C, *Facility Safety*; DOE-STD-1189-2008, *Integration of Safety into the Design Process*; and DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. For the PSDR and PSVR review, EA used selected objectives and criteria from EA Criteria and Review Approach Document (CRAD) 31-29, *Review of Nuclear Facility Preliminary Safety Basis Development (Rev. 0),* to guide the assessment. In particular, the PSDR assessment utilized the lines of inquiry in the General Information, Hazard and Accident Analysis, and Preliminary Design sections of the CRAD's first criteria, which govern the hazards and accident analysis and preliminary design of safety structures, systems, and components (SSCs).

EA independent oversight assessments focus strategically on selected aspects of nuclear safety that are essential to ensuring effective protection of co-located workers and the public, and the development of an understanding of the overall safety design basis. By reviewing selected aspects of the PSDR and supporting hazard analysis, the assessment addressed line management preparation, review, and approval processes that ensure integration of nuclear safety into the LAWPS design. EA examined key documents such as the LAWPS Safety Control Development and Design Integration report (RPP-RPT-58553) and the FHA.

EA attended the 30% gap design review in July 2016, and both parts of the 60% design review that were conducted in February and April 2017. EA also met with key LAWPS project team personnel who were responsible for developing the preliminary safety design basis documents and toured the area where LAWPS will be located. Appendix A lists the members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment. Appendix B provides a detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment that are relevant to the findings and conclusions of this report.

EA generally uses a written comment and response process to address issues identified during its review of safety design basis documents. During the assessment, EA provided comments on the draft PSDR to the LAWPS project team and received written responses in return. Follow-on discussions of the comments and written responses resulted in preliminary closure of a number of the initial comments in PSDR revision 0A. The final LAWPS project team responses satisfactorily resolved the remainder of the comments through stated actions to address the issues in the PDSA. Twenty-four comments, identified as discrepancies in the discussion of the results, are in closed status pending verification of the WRPS-stated PDSA actions. None of the identified discrepancies are deficiencies or findings. Attachment 1 contains a summary of the discrepancies discussed in this report that are pending closure in the PDSA.

5.0 RESULTS

Criterion: The PSDR will demonstrate the adequacy of the hazard analyses and the selection and classification of hazard controls, including consideration of the application of the principles associated with the hierarchy of controls. (DOE-STD-1189-2008, Section 6.3)

The PSDR should demonstrate the adequacy of the hazards analyses and the selection and classification of the hazard controls based on the maturity of the preliminary design, apply the principles associated with the hierarchy of controls, and include important safety design aspects in the preliminary design. These safety design aspects include:

- Site information that can affect LAWPS nuclear safety
- Summary of the hazard analyses, including process hazards evaluation, FHA, and criticality safety evaluation
- Selected safety SSCs and their safety function, functional classification, and required seismic and other natural phenomena hazards design criteria and applicable design code of record
- Functional requirements and performance criteria (including applicable design requirements from the supporting DOE guides) for safety SSCs
- Documentation of implementation of the nuclear safety design criteria of DOE Order 420.1C, Attachment 2, Chapter 1.

Sections 5.1 and 5.2 evaluate these safety design aspects of the PSDR. Section 5.3 evaluates the Federal review and approval of the PSDR.

5.1 Hazard Analysis

5.1.1 General Information

EA reviewed the general information and the site characteristics in the PSDR to verify that, at this stage of the preliminary design, the information is sufficient to support the hazard analysis.

The LAWPS preliminary design is approximately 60% complete. The supporting process flow diagrams and piping and instrumentation drawings are consistent with the preliminary level of design maturity and sufficient to support hazard analysis at the system level, with some component-level analysis complete. The site characteristic information is either in the PSDR or referenced in the Tank Farms Documented Safety Analysis (RPP-13033, *Tank Farms DSA*), and provides sufficient information to support safety-in-design associated with natural phenomena hazards, external hazards, and site environmental considerations. The PSDR also adequately describes nearby Hanford Site facilities and their interfaces with LAWPS.

5.1.2 Hazard Identification

EA reviewed the implementation of WRPS procedure TFC-ENG-DESIGN-C-47, *Process Hazard Analysis*, to verify compliance with the requirements in DOE-STD-1189-2008. The procedure defines the process for performing and documenting process hazard analyses (PrHAs). In addition to DOE-STD-1189-2008, the hazard analysis methodology is also intended to meet the guidance in DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*.

The hazard identification process was performed using a common checklist supported by historical records (such as occurrence reports), the assumed material-at-risk (MAR), energy sources, and LAWPS operations at the facility and system level of detail. Projections for the maximum anticipated quantities of MAR are suitable based on the preliminary design maturity. These projections are based on preliminary piping and instrumentation drawings, general arrangement drawings, and process flow diagrams. Standard industrial hazards are identified and appropriately screened from further consideration. Overall, the hazards identification and screening processes are appropriate.

Following the identification of hazards, the LAWPS project team used the hazard analysis process to develop a spectrum of hazard event scenarios that could be initiated by upsets in facility operations, natural phenomena hazards, and external man-made events. From these scenarios, the project team appropriately identified and developed representative and design basis events for release of hazardous materials.

5.1.3 Hazard Evaluation

EA reviewed the hazard analysis to determine whether the spectrum of facility and process upset events was appropriate. EA examined the analyzed hazard scenarios related to fires, explosions, loss of confinement, natural phenomena hazards, and man-made events. EA also evaluated some supporting consequence calculations to verify that unmitigated hazard analyses for workers and the public were appropriately conservative. An appropriate set of hazard scenarios, design basis accidents, and beyond design basis accidents were identified. EA did not identify additional hazards or new hazard event scenarios of greater consequence than those analyzed in the PSDR.

Overall, the LAWPS PrHA (RPP-RPT-57583, *Process Hazard Analysis (PrHA) for LAWPS*) is adequate for this preliminary level of design maturity. The LAWPS project used several techniques, including hazard and operability studies, to evaluate the potential hazardous events at the facility and prepared a hazard analysis report to support the PSDR. The hazard evaluation team divided the LAWPS process into study nodes for analysis at the specific locations where process systems interface or unique activities occur. The team evaluated each node for those hazardous conditions that could result in leaks or releases of hazardous materials with potentially significant consequences to the public, co-located workers, or facility workers. The resulting summaries of the cause, frequency, consequences, existing and recommended controls, potential emergency response actions, and MAR are sufficiently detailed to understand the postulated hazards, event sequence, and hazard controls. The frequency estimates and unmitigated consequence analyses are appropriate and conservative.

EA reviewed a number of the consequence calculations that support the PSDR, including calculations for determining the atmospheric dispersion coefficients (χ/Qs) for loss of confinement events due to pressurized releases and flammable gas explosions. Conservative assumptions were used in deriving the offsite χ/Q value (e.g., ground-level, non-buoyant release, point source release, and particle size of 3 microns). The atmospheric dispersion coefficient for calculating onsite consequences is consistent with DOE-STD-3009-2014. The analytical inputs are conservative, and the input assumptions for the remaining calculations are typically bounding. For example, the flammable gas explosion calculation conservatively assumes 1,000 hours of undetected process upset and accumulation of flammable gas leading to the explosion. The results of the calculations appropriately conclude that no public radiological or chemical exposure guidelines are challenged and no safety class controls are required. Further, the consequences to the co-located worker calculated in the PSDR do not exceed radiological exposure guidelines, and the pressurized spray leak scenario is the only event that exceeds onsite chemical evaluation guidelines for the co-located worker and requires safety significant controls.

The PSDR adequately describes the hazard evaluation methodology and summarizes the results of the PrHA. RPP-RPT-58856, *The Low Activity Waste Pretreatment System Hazard Evaluation Database Report*, summarizes the hazard evaluation results, provides a bridge from the PrHA to the PSDR, and affords a means of communication with the project design engineers. The database contains a table documenting the bases for the consequences of events with “no controls” and a table summarizing the hazard events (by node), credited preventive SSCs or Specific Administrative Controls (SAC), and important contributors to defense-in-depth (DiD). For each specific hazard evaluation node, PSDR Table E-1, *LAWPS PrHA Results*, provides information relating to the process deviation, the hazardous material description, the cause, the unmitigated frequency, the consequence categories, identified controls, actions to be taken, and links to the hazard evaluation database. Conservative preliminary hazard categorization as Hazard Category 2 was made in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, based on the expected inventory of cesium-137 in the ion exchange (IX) columns.

The PSDR also provides an appropriately detailed discussion of the methods and criteria used to identify and classify the safety SSCs and administrative controls (ACs) in the Chapter 3 hazard and accident analysis sections. PSDR Section 3.3.1.3 describes the methodology and criteria for safety functional classification of hazard controls. This description includes classification of controls that protect against both radiologically and chemically hazardous releases. The discussion of functional classification of hazard controls adequately incorporates DOE-STD-1189-2008 requirements. Section 3.3.2.3 develops suitable categories of hazard scenarios as representative and design basis accidents based on unmitigated consequences. The section appropriately identifies flammable gas explosions, direct radiation exposures, and chemical burns as significant facility worker hazards.

PSDR Section 3.3.2.5 includes a suitably detailed discussion of the hazards associated with facility worker safety and the SSCs identified as hazard controls, including description of SSC safety functions and functional requirements. The subsection also appropriately addresses SSCs determined to be functionally classified as DiD. Table 3-7 summarizes the hazard events, the safety significant controls, and the technical safety requirements (TSRs). Table 3-8 addresses other important DiD safety features, while Table 3-9 summarizes all the safety features that provide protection for facility workers.

Although the overall hazard evaluation is adequate, EA identified two discrepancies involving hazards that were not fully evaluated. The first discrepancy relates to the hazard evaluation of potential routing of incompletely eluted spent resin to the resin handling room; in this case, there was no control to verify that the IX columns were properly eluted prior to initiating a new adsorption cycle or a transfer to the spent resin handling area. The second discrepancy relates to the incomplete evaluation of the potential effects of lightning on power distribution and instrumentation and controls networks. WRPS committed to address these discrepancies in the PDSA.

Overall, the PSDR provides a sufficiently detailed description of the hazard identification and hazard analysis results and is sufficiently complete to support advancing the facility design to the 90% design phase. The supporting PrHA addresses an appropriately comprehensive set of hazard events and is supported by conservative estimates of event consequences. The calculations appropriately conclude that no public radiological or chemical exposure guidelines are challenged and no safety class controls are required. Hazards to both co-located and facility workers are identified and hazard controls selected. The PSDR-derived safety SSCs are consistent with the logic in the hazard analysis. Their designation as safety significant SSCs is appropriately focused on protecting the co-located and facility workers. The safety strategy appropriately relies on robust piping, vessels, and underground vaults and pits to confine radioactive and hazardous chemical substances and on a variety of controls to prevent flammable gas accidents and direct radiation hazards to facility workers (e.g., DiD is provided by removing cesium-137 via an elution system and using active vessel and vault ventilation systems).

5.1.4 Nuclear Criticality Safety

EA reviewed the documentation supporting the identification of criticality controls for conformance to DOE-STD-3007-2007, *Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities*. EA found that the preliminary evaluation correctly identifies potential process upsets and adequately addresses the nuclear criticality safety of proposed operations.

To support the LAWPS preliminary design, a preliminary criticality safety evaluation report (CSER) (RPP-RPT-59350, *Preliminary Criticality Safety Evaluation Report for LAWPS*), prepared to the requirements of DOE-STD-3007-2007, concluded that fissile material operations at LAWPS will remain subcritical under all normal and credible upset conditions. Consequently, the preliminary CSER did not derive any engineered controls.

Based on planned waste characteristics, the preliminary CSER analyzed fissile inventories from certain supernate and saltcake wastes from various High-Level Waste tanks. The criticality safety of the fissile materials during LAWPS processing is demonstrated by comparing operations under normal and credible upset conditions to safe sub-critical limits. The analytical approach is appropriate, and the preliminary conclusions are conservative.

Because the anticipated supernate processed through LAWPS has only low fissile material concentrations, it is appropriate that only administrative criticality safety controls are specified. Controls include limiting the fissile material feed characteristics, which will be verified by sample analysis. Two other criticality safety controls are tied to a resin elution (after no more than 14 days of full-flow operation) and resin replacement (after no more than 180 days of full-flow operation). Overall, criticality safety will be adequately protected by implementation of these ACs via work process documents.

5.1.5 Fire Hazards Analysis

EA reviewed the LAWPS FHA (RPP-RPT-57123, *Fire Hazard Analysis for the Low-Activity Waste Pretreatment System (Project T5L01*), along with the supporting design documents, to evaluate the fire hazard evaluation processes and resulting fire hazard controls. EA reviewed the analyzed fire events and potential consequences related to explosions, loss of confinement, and earthquake-induced fires. The FHA adequately evaluates the hazards and identifies a broad set of LAWPS fire hazard controls, and the results are adequately integrated into the PSDR.

The FHA addresses appropriate nuclear safety requirements and objectives, and is consistent with the requirements in DOE Order 420.1C. The FHA identifies potential fire hazards and scenarios that adequately support functional classification of fire protection SSCs. In addition, the FHA analyzes and evaluates major fire hazards, and proposes fire prevention and exposure control strategies (for instance, design features, combustible loading restrictions, and spill containment). The PSDR adequately summarizes the analysis in the FHA through a comprehensive evaluation of the fire scenarios and the potential damage to the process building and critical supporting equipment.

5.2 Preliminary Design

5.2.1 Safety System Functional Classification and Design Criteria

EA reviewed the PSDR and select supporting design documentation to verify that the functional classification of select safety SSCs is appropriate and that adequate design criteria for these systems are identified.

PSDR Chapter 4 properly identifies safety significant SSCs and references hazard events from Chapter 3. The PSDR addresses the requirements of DOE-STD-1189-2008 and generally includes appropriate statements of the safety function, a summary system description, a system evaluation (including a description of the interfacing systems, system boundaries, and support systems), and identification of key remaining design activities for each safety significant SSC. In most cases, the PSDR properly identifies the safety functions and associated functional requirements for the safety SSCs, and establishes an initial set of performance criteria for the functional requirements. The system safety functions and functional requirements provide an adequate basis for advancing the facility design to the 90% design phase.

EA identified a number of discrepancies requiring resolution in the PSDR and PDSA. First, the PSDR system boundary descriptions and interfaces, safety functions, and functional requirements for two safety SSCs were not accurately defined. For example, the boundary description for the standby tank exhaust system (STES) did not address all the systems and components necessary, along with their functional requirements, to achieve the safety function. The PSDR did not include performance criteria to require flow balancing and/or lockable manual valves on the process vessel vent exhaust to the STES, which are necessary to ensure adequate exhaust flow under normal conditions and on a loss of the building and vault ventilation systems. The building and vault ventilation system normally exhausts the process vessels through the process vessel ventilation system. Further, a recent change in the control strategy for the IX column and treated waste delay tank vent systems that would direct all vented gas to the cesium product tank headspace, as opposed to the current control strategy which vents IX columns to break tanks, was not fully integrated into the PSDR. In addition, the requirement that the cesium product tank maintain sufficient volume to dilute the initial surge of gas from the IX column and treated waste delay tank vent system to below 60% of the Lower Flammability Limit was not identified as a safety function, nor was it provided as a performance criterion. As a result, the description of the vent systems safety functions and functional requirements in the draft PSDR was incomplete. WRPS corrected these discrepancies in the approved PSDR.

EA also identified a number of discrepancies that WRPS committed to address in the PDSA. For some safety SSCs, the PSDR provides an incomplete set of performance criteria for the identified functional requirements. For example, the IX column and treated waste delay tank vent system is interlocked to shut down the filter feed pump, yet the PSDR does not include performance criteria regarding the interlock function and sequence of operation. In addition, several Chapter 4 system evaluations are missing discussion and analysis of the support and interfacing systems that have the potential to affect safety SSC operation. For example, the PSDR did not identify or evaluate the potential for non-safety components, supplied with the safety significant backup power, to adversely affect the performance of the backup power system's safety function. Also, in some cases, functional requirements and performance criteria for safety system components have not been included. For example, the PSDR contains no discussion regarding the method of powering instruments or processing instrument signals in order for the system boundaries and interdependencies to be evaluated.

In summary, while some identified discrepancies remain to be addressed in the PDSA, the PSDR appropriately classifies safety systems and establishes their safety functions, functional requirements, and performance criteria for this stage of design maturity.

5.2.2 Specific Administrative Controls

EA reviewed the ACs identified in the PSDR to verify that the PSDR provides a satisfactory basis for determining the SACs and their required safety functions. PSDR Section 3.3.1.3 establishes the control selection and classification process, and includes a section describing the process for classifying ACs as SACs. This process is consistent with DOE-STD-1189-2008 and DOE-STD-1186-2004, *Specific Administrative Controls*.

Nevertheless, the PSDR includes two discrepancies involving ACs, performing safety-related functions, that are not properly designated as SACs. AC 5.9.4, *Waste Characteristics Controls*, was inappropriately characterized as a TSR AC Key Element, rather than as a SAC. WRPS committed to include this AC as a SAC in the PDSA. In addition, AC 5.9.1, *Vault and Pit Cover Installation and Sample Cabinet Door Closure*, is incorrectly classified as a TSR AC Key Element. If the covers are not installed, the toxicological consequences to the co-located workers of a pressurized spray leak (Section 3.4.3.1) are likely unacceptable, because the credited primary piping pressure boundary would not sufficiently reduce the risk to the workers. WRPS committed to include installation of the cover blocks as a TSR condition for entering Operations Mode in the PDSA. Crediting installation of the vault and pit covers appropriately provides a substantial layer of protection that physically obstructs the flow from the spray leak.

5.2.3 Defense-in-Depth Structures, Systems, and Components

EA evaluated the design criteria for selected DiD systems per the requirements of DOE Order 420.1C and DOE-STD-1189-2008.

The PSDR describes DiD for confinement of hazardous materials and identifies a number of SSCs as providing a DiD function for hazardous events, such as flammable gas explosions and pressurized waste leak accidents. For example, the PSDR identifies an AC Key Element for ignition controls as an important contributor to DiD. Other DiD features identified as non-safety significant include the LAWPS ventilation system (building and vault ventilation system and the process vessel ventilation system), the IX column elution system, the process control system, and the permeate heat-exchanger radiation monitor.

The LAWPS ventilation system is an integral part of the overall layer of protection strategy for reducing risk associated with explosions and pressurized spray leak events. The LAWPS ventilation system is provided as an additional, active confinement system that includes high-efficiency particulate air filtration and support equipment. This system has been identified as a DiD feature for preventing contamination spread by providing cascaded airflows (differential pressures) and filtration. The ventilation system is designed to provide DiD active confinement ventilation in accordance with DOE Guide 420.1-1A, *Nonreactor Nuclear Safety Design Guide for Use with DOE O 420.1C Facility Safety*, Appendix A.

The elution system also provides DiD to remove adsorbed cesium-137 from the IX resin and moves it to the Cs product tank, which stops flammable gas generation in the IX column prior to accumulation to unacceptable quantities. Elution would be performed prior to safety timer timeout and activation of the IX column and treated waste delay tank vent system. The elution system is a general service load on the backup power system to allow elution in the event of a loss of power.

Overall, the LAWPS safety strategy uses a multi-layer approach in accordance with the requirements of DOE Order 420.1C and DOE-STD-1189-2008, which appropriately incorporates DiD SSCs to prevent or mitigate the unintended release of hazardous materials to workers, the public, and the environment.

To summarize, the LAWPS preliminary safety design basis adequately addresses the requirements of DOE-STD-1189-2008 and DOE Order 420.1C. The PSDR appropriately integrates the supporting hazard analyses with the nuclear safety design and is consistent with the hierarchy of controls in the DOE order. The PSDR also incorporates important nuclear facility design requirements that provide multiple layers of protection and successive physical barriers for protection against radioactive and hazardous chemical material releases.

5.3 Preliminary Safety Validation Report

Criterion: The reviewer should refer to DOE-STD-1189-2008, Appendix I, for detailed guidelines on the expected contents for a PSDR and the reviewer of the PSDR shall also confirm that it adequately addresses the following safety design basis aspects for the preliminary design phase (items 1 through 6 below). (DOE-STD-1104-2014, Section 8.5)

EA reviewed the PSVR to determine its adequacy as the approval basis for the PSDR, as required by DOE-STD-1104. The Safety Basis Review Team (SBRT) followed the *Safety Basis Review Plan for LAWPS* and used the lines of inquiry to ensure the thoroughness of the review.

The SBRT included members with appropriate subject matter expertise in nuclear safety, criticality safety, and safety systems oversight. The SBRT concluded that the PSDR presents sufficient information for the preliminary design, meets the format and content requirements of DOE-STD-1189-2008, and acceptably resolves SBRT (and EA) comments. Based on this assessment, the SBRT recommended approval of the LAWPS PSDR.

The PSVR addresses the approval bases identified for review in DOE-STD-1104-2014, which include verification that the design requirements of DOE Order 420.1C are met, assessment that the PSDR presents a viable design solution based on the safety functions identified in the hazard analysis, and confirmation that the appropriate design criteria are identified. For each approval basis, the PSVR provides a satisfactory basis for recommending approval of the PSDR, including a summary of the contents of the PSDR.

The SBRT compared the content review of the PSDR with the requirements of DOE-STD-1189-2008. The SBRT concluded that the hazards analysis performed for the LAWPS PSDR was developed consistent with DOE-STD-1189-2008 and that it follows an acceptable format provided in DOE-STD-3009-2014. The PSVR also notes that all unmitigated offsite consequences for postulated events are low. The SBRT review resulted in 40 comments on the final version of the PSDR, categorized according to their significance and formally transmitted to the LAWPS project team for resolution. After the transmittal, the SBRT held meetings with LAWPS project team management and staff to resolve comments and develop a path forward.

The PSVR adequately summarizes the important issues raised in the SBRT comments, which were resolved in the PSDR, and includes the agreed-on resolutions to specific SBRT comments that remain open. The PSVR contains two conditions of approval (COAs).

- COA No. 1 involves the Critical Decision (CD) milestone 3A long lead procurements and is tied to three SBRT comments that must be resolved prior to executing CD-3A.
- COA No. 2 involves issues (tied to 23 SBRT comments) raised in the SBRT review that must be resolved before issuing the PDSA.

The PSVR also identified two ACs that WRPS agreed to implement as SACs in the PDSA, consistent with EA-identified discrepancies (see Section 5.2.2).

The PSVR adequately documents review of the PSDR and provides an understanding of the design basis accidents, the consequences, and the controls incorporated into the LAWPS design to prevent significant hazard events. The PSVR correctly concurs in the hazard categorization for the LAWPS facility based on DOE-STD-1027-92.

Overall, the PSVR includes discussion of the modifications to the design that resolve the SBRT safety concerns and appropriately concludes that there is no remaining impediment to proceeding to the final design phase.

6.0 FINDINGS

EA identified no findings or deficiencies during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified no OFIs during this assessment.

8.0 ITEMS FOR FOLLOW-UP

During review of the PDSA, EA may follow up to verify closure of actions for the comments provided to the LAWPS project team.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: July 10-20, 2017
Offsite Assessment: May, August, and September 2017

Office of Enterprise Assessments (EA) Management

William A. Eckroade, Acting Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy Director, Office of Environment, Safety and Health Assessments
C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments
Kevin G. Kilp, Acting Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

Steven C. Simonson
John S. Boulden III
Thomas R. Staker
William E. Miller
Michael A. Kilpatrick

EA Site Lead for WTP

Samina A. Shaikh

EA Assessors

James O. Low – Lead
Kevin E. Bartling
Michael V. Frank
Roy R. Hedtke
David J. Odland
Jeffrey L. Robinson

Appendix B
Key Documents Reviewed, Meetings/Interviews, and Observations

Documents Reviewed

- 19-2-006-2, *Low-Activity Waste Pretreatment System Project No. 31269 (T5L01), Safety Instrumented System Control Narrative*, Rev A, AECOM, April 2017
- 31269-14-CALC-0004, *Ash Mitigation Calculation*, Rev. A, AECOM, April 2017
- 31269-21-RPT-005, *Process/Mechanical FMEA*, Rev A, AECOM, April 2017
- 31269-22-DBD-001, *Low-Activity Waste Pretreatment System Project No. 31269 (T5L01) Design Basis Document*, Rev. 1, AECOM, January 2017
- 31269-22-FDD-001, *Low-Activity Waste Pretreatment System Project No. 31269 (T5L01) Facility Design Description for LAWPS Facility*, Rev. A, AECOM, April 2017
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<u>Meetings/Interviews</u>

WRPS

LAWPS Project

- Safety Analysis Engineers (4)
- Facility Safety Engineer
- Manager of Engineering
- Deputy Manager of Engineering
- Project Engineering Manager, Nuclear Safety Engineering
- Deputy Nuclear Safety Manager
- Fire Protection Engineer
- Mechanical Engineer – Fire Protection

ORP

- ORP LAWPS Project Federal Project Director
- ORP LAWPS Project Technical Lead
- ORP Safety Basis Review Team Leader

Observations

- 30% Gap Design Review
- 60% Design Review (Parts A & B)
- Site Tour

Attachment 1
Summary of Discrepancies Pending Closure in the PDSA

1. The description and evaluation of a potential routing of incompletely eluted spent resin to the resin handling room are incomplete.
2. The potential effects of lightning on power distribution and instrumentation and controls networks are not completely evaluated.
3. In a few instances, the performance criteria related to system functional requirements are missing.
4. Several Chapter 4 system evaluations are missing discussion of support and interfacing systems.
5. In a number of instances, detailed functional requirements and performance criteria for system components are not included.
6. Some safety significant AC Key Elements are not appropriately designated as Specific Administrative Controls.