Office of Enterprise Assessments
Targeted Assessment of the
Waste Treatment and Immobilization Plant
High-Level Waste Facility Radioactive Liquid Waste Disposal
System Safety Basis Change Package

May 2016

Office of Nuclear Safety and Environmental Assessments
Office of Environment, Safety and Health Assessments
Office of Enterprise Assessments
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Acronyms

BNI	Bechtel National, Inc.
CDR	Control Decision Report
CFR	Code of Federal Regulations
CLW	Co-Located Worker
CN	Change Notice
CP	Change Package
CRAD	Criteria and Review Approach Document
DBA	Design Basis Accident
DiD	Defense in Depth
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
FW	Facility Worker
HAT	Hazards Analysis Team
HAR	Hazards Analysis Report
HCP	Concentrate Receipt Process System
HLW	High-Level Waste
MAR	Material at Risk
ORP	DOE Office of River Protection
PDSA	Preliminary Documented Safety Analysis
PTF	Pretreatment Facility
RLD	Radioactive Liquid Waste Disposal System
SAC	Specific Administrative Control
SBRT	Safety Basis Review Team
SC	Safety Class
SER	Safety Evaluation Report
SSC	Structures, Systems, and Components
WPC	Wet Process Cell
WTP	Waste Treatment and Immobilization Plant

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EXECUTIVE SUMMARY

The Office of Nuclear Safety and Environmental Assessments, within the U.S. Department of Energy's (DOE) independent Office of Enterprise Assessments (EA), conducted an assessment of the Hanford Site Waste Treatment and Immobilization Plant (WTP) preliminary documented safety analysis (PDSA) change package for the redesign of the High-Level Waste Facility radioactive liquid waste disposal system. This assessment is part of a broader EA assessment to evaluate the multi-year Bechtel National, Inc. (BNI) activities associated with upgrading the High-Level Waste Facility PDSA. The High-Level Waste Facility is a hazard category 2 nuclear facility designed to vitrify high-level waste received from the Pretreatment Facility and is an integral part of WTP. BNI is designing and constructing the High-Level Waste Facility under the direction and oversight of the DOE Office of River Protection (ORP).

This assessment addressed whether aspects of the PDSA change package conformed to the requirements of DOE-STD-3009-94 Change Notice 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*. In addition, EA assessed the adequacy of the ORP-issued safety evaluation report, which serves as the basis of approval for the PDSA change package. BNI implemented the radioactive liquid waste disposal system redesign to address technical issues and nuclear safety concerns associated with potential hydrogen explosion hazards created by the presence of non-Newtonian[1] high-level waste in the system. The safety design strategy for this event was designed to prevent non-Newtonian high-level waste from entering the system.

Overall, the radioactive liquid waste disposal system redesign changes to the PDSA hazard and accident analyses are appropriate for the complexity of the facility's operations and hazards. The PDSA change package and supporting documents adequately identify and analyze the hazards and contain an appropriate set of hazard controls in accordance with DOE-STD-3009-94 Change Notice 3. The redesign created no new design basis accident scenarios and eliminated non-Newtonian high-level waste hazards in the system.

The ORP safety basis review team appropriately reviewed the PDSA change package and prepared the safety evaluation report. The safety evaluation report documents acceptance of the PDSA change package in accordance with the requirements of DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*. The safety evaluation report appropriately determined that the proposed PDSA changes are acceptable and that there is reasonable assurance that these changes will not adversely affect the health and safety of the public, workers, and environment.

[1] A **non-Newtonian fluid** is a fluid with properties that differ in any way from those of Newtonian fluids. Most commonly, the viscosity (the measure of a fluid's ability to resist gradual deformation by shear or tensile stresses) of non-Newtonian fluids is dependent on shear rate or shear rate history. For Newtonian fluids, there is a linear relationship between the shear stress and the rate of shear (velocity gradient). For non-Newtonian fluids, the relationship is not linear. With regard to waste processed in the High-Level Waste Facility, non-Newtonian waste can accumulate hydrogen produced through the radiolytic decomposition of waste components, leading to the potential for a rapid, episodic release, allowing the vessel vapor space to exceed the lower flammability limit.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of the Hanford Site Waste Treatment and Immobilization Plant (WTP) preliminary documented safety analysis (PDSA) change package (CP) for the redesign of the High-Level Waste (HLW) Facility radioactive liquid waste disposal system (RLD). This assessment is part of a broader EA assessment to evaluate the multi-year Bechtel National, Inc. (BNI) activities associated with upgrading the HLW PDSA. The purpose of this assessment was to evaluate changes in the PDSA in response to the RLD redesign, which addresses technical issues and nuclear safety concerns associated with non-Newtonian HLW feed into the RLD.

EA performed the onsite portion of this assessment in August and October 2014. Document review took place in August and November 2015, and EA completed assessment of the Office of River Protection (ORP)-issued safety evaluation report (SER) in March 2016.

2.0 SCOPE

EA evaluated the BNI-proposed changes to 24590-WTP-PSAR-ESH-01-002-04, *Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information*, due to redesign of the HLW Facility RLD system. The scope included changes to the PDSA, as well as the supporting hazards analysis report (HAR) (24590-HLW-HAR-NS-13-0001-07, *Hazards Analysis Report for High-Level Waste Facility, Volume 7, Radioactive Liquid Waste Disposal System and Autosampling System*) and the control decision report (CDR) (24590-HLW-RPT-NS-15-002, Rev. 1). The assessment included hazards analysis candidate control(s) evaluation and selection as Technical Safety Requirement-level controls for overall conformance to DOE-STD-3009-94 Change Notice (CN) 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*. EA conducted the assessment under the *Plan for the Independent Oversight Review of the Hanford Site Waste Treatment Plant High-Level Waste Facility Preliminary Documented Safety Analysis Upgrade*, dated July 2014.

The scope of this assessment included an evaluation of the adequacy of the PDSA CP and associated ORP-issued SER as developed by the ORP safety basis review team (SBRT).

3.0 BACKGROUND

The HLW Facility is a hazard category 2 nuclear facility designed to vitrify the HLW received from the Pretreatment Facility (PTF) and is an integral part of WTP. A DOE Headquarters Construction Project Review of the WTP conducted in 2011 raised concerns that the safety structures, systems, and components (SSCs) and functional requirements contained in WTP PDSAs were not supported by hazards and accident analysis and that the PDSA-credited[2] controls may not have been adequately incorporated into the project design criteria. BNI performed a management assessment (24590-WTP-

[2] Credited – for the purpose of this report denotes a control used for specific hazard event risk reduction

SAA-ENS-12-001) which identified numerous technical issues and provided corrective actions for the HLW PDSA. In 2012, ORP restricted engineering, procurement, and construction activities for the HLW Facility because of open technical issues, as well as misalignments of the design media and PDSA. ORP directed BNI to resolve open technical issues and recommended HLW design changes. These issues involved concerns about RLD system reliability and potential hydrogen explosion hazards. Options for RLD redesign were identified by BNI in the ORP-approved safety design strategy (24590-HLW-PL-ENS-13-0001, *Safety Design Strategy for the High-Level Waste Facility*) which, if properly implemented, can resolve the potential hydrogen explosion issue associated with the RLD system (i.e., non-Newtonian HLW in the Plant Wash and Drains Vessel [RLD-VSL-00008]).

Prior to the redesign, non-Newtonian waste in the RLD-VSL-00008 vessel was prevented from reaching the hydrogen lower flammability limit by a safety class (SC) purge system that injected air into the vessel vapor space to dilute and remove accumulated hydrogen gas. The RLD vessel design also included a SC overflow feature, which allowed an open ventilation path for hydrogen release. As a passive design feature, the vessel was designed to withstand an internal hydrogen explosion without loss of confinement. The redesign of the RLD vessel and associated feed system physically eliminated the potential for non-Newtonian waste entering RLD-VSL-00008.

4.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*. EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides.

As identified in the assessment plan, *Plan for the Independent Oversight Review of the Hanford Site Waste Treatment Plant High-Level Waste Facility Preliminary Documented Safety Analysis Upgrade,* EA assessed the adequacy of the PDSA CP in select areas. The evaluation included portions of the HLW Facility system descriptions, hazards analysis, accident analysis, safety SSC identification, and functional classification. The assessment scope was limited to sections of the PDSA that were revised because of the redesign of the RLD system.

The PDSA review criteria for the PDSA CP are selected from EA Criteria and Review Approach Document (CRAD) 31-02. EA used elements of EA CRAD 31-03 for assessing the Federal review and approval of the PDSA CP.

EA examined contractor documentation associated with revising the PDSA, including the final HAR, final CDR, draft hazards analysis event tables, hazard identification tables, what-if questions, referenced calculations and analysis, technical basis documents, design media, and design specifications. As part of this assessment effort, EA evaluated ORP SBRT documentation for PDSA CP review and approval, including the ORP procedure for WTP safety basis management and records for documenting, communicating, and dispositioning technical review comments.

EA performed field oversight activities associated with this assessment over an extended period that included observation of Hazards Analysis Team (HAT) meetings in August and October of 2014. EA reviewed the draft hazards analysis event tables and provided comments to BNI for written response. EA met with the BNI HAT to clarify the response, which sometimes led to the hazard event tables being modified. EA documented these field oversight activities in separate EA reports (i.e., EA-WTP-HLW-2014-08-18 and EA-WTP-HLW-2014-10-20).

BNI initially transmitted the PDSA CP (revision 0) for ORP review and approval in May 2015. The ORP SBRT returned two sets of comments, one set from the SBRT and one set from EA reviewers. The CP was subsequently updated (revision 1) and resubmitted for ORP review and approval in October 2015. EA reviewed the PDSA CP (revision 1), HAR, and CDR; provided comments; and met with BNI in November 2015 to resolve comment responses. The SBRT issued its SER in March 2016. EA subsequently reviewed the SER, provided comments, and evaluated responses.

Appendix A lists the members of the EA assessment team, the Quality Review Board, and the EA management responsible for this assessment. A detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B. References used for this assessment are listed in Appendix C.

5.0 RESULTS

The PDSA must provide a reasonable basis for the conclusion that the nuclear facility can be operated safely. This can be demonstrated by a safety basis that derives aspects of design necessary to satisfy the nuclear safety design criteria described in DOE Order 420.1B, *Facility Safety* (DOE Order 420.1C is the current revision, however BNI is contractually obligated to meet the requirements of DOE Order 420.1B). To establish the PDSA, 10 CFR 830, *Nuclear Safety Management*, delineates in part 206, *Preliminary Documented Safety Analysis*, three criteria for new DOE hazard category 2 nuclear facilities. The first three subsections of the results evaluate the PDSA CP against these criteria. 10 CFR 830 references a table of safe harbor methodologies for use in preparing documented safety analyses (DSAs). Implementation of DOE-STD-3009-94 CN3 is required by the BNI contract with ORP; therefore, the criteria to evaluate the 10 CFR 830.206 PDSA requirements are taken from DOE-STD-3009-94 CN3. Similarly, DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, provides the framework and criteria for approving safety basis and safety design basis documents as required by 10 CFR 830. Consequently, the last subsection evaluates the Federal review and approval of the PDSA CP using DOE-STD-1104-2014.

5.1 Safety Analysis

Criterion:
The contractor responsible for a new hazard category 1, 2, or 3 DOE facility or a major modification to a hazard category 1, 2, or 3 DOE nuclear facility must prepare a PDSA for the facility. (10 CFR 830.206a)

EA reviewed the HAR and CDR to determine whether the PDSA CP was consistent with the requirements of DOE-STD-3009-94 CN3. The HAR documents the results of the HAT's hazards analysis activities and includes completed what-if questions and hazard evaluation tables that document the analysis of individual hazard events. The events are organized by the associated location in the system (i.e., analysis node) and event type (e.g., fire, explosion, natural phenomena hazards, loss of confinement). The HAR appropriately identifies the radiological material at risk (MAR), the chemical hazards, and potentially hazardous energy sources, and analyzes an acceptable set of hazard events. The HAR provides a list of candidate controls for each event, including engineered and administrative controls that provide either preventive or mitigative safety functions. The results of the hazards analysis are appropriately presented as a set of representative and unique candidate design basis accidents (DBAs) with corresponding candidate control sets.

The CDR evaluates the HAR set of representative and unique candidate DBAs, along with the candidate controls, to develop the final DBAs and their associated selected controls. DOE-STD-3009-94 CN3 requires selected controls to be fully evaluated in chapter 4 of the PDSA and derived as Technical Safety

Requirements. CDR subsections appropriately discuss the worker protection hazard controls for each DBA, providing the hazard control strategies and summary tables that identify the credited control name, safety function, and functional classification. The PDSA CP discusses each of the DBAs, including adequate summaries of the scenario and the unmitigated consequences to workers and the public. Control selection was primarily based on the preferred hierarchy of controls from DOE-STD-3009-94 CN3. The CDR control selection process consists of selecting candidate controls capable of reducing the risk to an acceptable level through risk bin ranking methodology, and then by adding controls as "defense in depth" (DiD), which are not credited as part of the Technical Safety Requirement control set. A typical hazard control strategy, in accordance with the hierarchy of controls from DOE-STD-3009-94 CN3, relies on engineered passive design features to prevent the event and a combination of engineered features and administrative controls classified as DiD to provide additional layers of protection.

EA reviewed the PDSA CP to verify that the results of the HAR and CDR had been incorporated. The PDSA CP provides a description of new hazard events that affect the facility worker (FW) and revisions to DBAs resulting from the RLD redesign. Although there were new hazard events because of the RLD redesign, including events relating to fires, explosions, loss of confinement, and direct exposure, no new DBAs were identified. The PDSA CP provides adequate descriptions of the updated hazard events and consequences as derived from the HAR. The PDSA CP also appropriately incorporated safety control strategies from the CDR and correctly identified the functional classification of credited safety SSCs and DiD controls. The CP adequately defines the safety functions, functional requirements, and performance criteria of credited SSCs impacted by the RLD redesign. The application of credited controls reduces the mitigated risk from updated hazard events and revised DBAs to an acceptable level (risk bin III or IV).

Although hazard events in the PDSA CP are generally clear and complete, EA identified two discrepancies and provided these discrepancies to BNI through the comment submission process:

- Direct exposure events did not address the possibility of backflow in the bulge from leaks in the concentrate receipt process system (HCP) transfer line. (This event could pose high consequences to the FW).

- The functional requirement for coaxial piping in the WTP HLW wet process cell (WPC) does not include the design requirement to prevent leakage into HCP-SUMP-00001, which can backflow into the bulge. Only RLD-SUMP-00001 is specified. Design documents (i.e., piping and instrumentation diagrams) correctly require coaxial piping to be installed the full length of the WPC to the melter cave in order to prevent leakage from entering both sumps.

BNI appropriately responded to these discrepancies by committing, in the comment response, to make the appropriate changes in the PDSA revision following completion of the process hazards analysis.

The revised hazards analysis, DBAs, and credited controls for the PDSA CP are appropriate for the complexity of the facility's operations and hazards. The PDSA hazards analysis methodology, as supported by the HAR, is clear and is consistent with DOE-3009-94 CN3. The PDSA adequately incorporates revised DBAs, selected in the HAR and evaluated in the CDR, and uses them to derive safety SSC functions and requirements. Adequate discussions of the safety control strategies and hazard control sets for worker protection address each DBA. DBAs incorporate a control strategy that properly identifies and functionally classifies safety SSC controls. The control strategy appropriately incorporates engineered, passive design features to prevent the DBAs. Additionally, the overall DBA control strategy includes DiD administrative and engineered controls to provide multiple layers of protection. The new control strategies for DBAs provide adequate assurance of protection to the workers and the public. Along with BNI actions to address the stated discrepancies, the safety

functions, functional requirements, and performance criteria of new and modified safety SSCs impacted by the RLD redesign are clearly defined and adequate.

5.2 Nuclear Safety Design Criteria

Criterion:
The contractor responsible for a new hazard category 1, 2, or 3 DOE nuclear facility or a major modification to a hazard category 1, 2, or 3 DOE nuclear facility must obtain DOE approval of the nuclear safety design criteria to be used in preparing the PDSA unless the contractor uses the design criteria in DOE Order 420.1B, Facility Safety. (10 CFR 830.206.b.1)

EA reviewed the PDSA CP for implementation of DOE Order 420.1B nuclear safety design criteria. DOE Order 420.1B requires that new facilities integrate safety criteria into the design that incorporate multiple layers of protection to protect the health and safety of the public, workers, and environment. DOE Order 420.1B also requires that these safety criteria be integrated into the design by timely development of the safety analysis to identify safety SSCs and their functions. The PDSA CP identifies safety SSCs, as well as administrative controls, that prevent non-Newtonian HLW from entering the RLD (i.e., RLD-VSL-00008 and associated feedlines). The redesign includes alterations to the RLD vessels and their functions, rerouting sump discharge destination, rerouting autosampling system drains, replacing transfer ejectors and reverse flow diverter systems with centrifugal pumps, adding bulges, extending coaxial piping on the feed transfer lines, adding coaxial melter cave cross-connect lines, and removing melter feed preparation and melter feed vessel steam ejectors.

The control strategy for the RLD minimizes MAR by preventing non-Newtonian HLW from entering RLD-VSL-00008, in accordance with DOE Order 420.1B. The feed to RLD-VSL-00008 is limited to waste streams that include low-activity liquid effluents from decontamination systems, HLW off-gas treatment drains, and various HLW plant and vessel washes. These low-activity waste streams can include various chemicals (e.g., nitric acid, caustic solutions) and can be hazardous to the FW on contact; however, unmitigated radiological consequences to the FW are determined to be "low." The magnitude of the low-activity waste chemical consequences to the FW depends on the release mechanism (i.e., spray release can saturate the FW with hazardous chemicals leading to high consequences, while non-energetic leaks only result in low consequences). Sumps in the WPC have leak detection and alarm systems that would prompt HLW Facility operator action in the event of a leak, thereby minimizing the low-activity waste release volume. The WPC provides a robust confinement structure for any breach of RLD-VSL-00008 or feedline confinement boundaries.

The PDSA CP addresses the WPC hydrogen explosion hazard introduced by the addition of the HLW melter feed cross connect line within the WPC. Failure to flush the cross connect line can lead to an accumulation of hydrogen, potentially resulting in an explosion and release of HLW into the WPC. The piping is credited as a passive design feature that can withstand hydrogen deflagrations, detonations, and reflected deflagration to detonation transition events using robust design criteria and materials of construction. The cross connect line design feature is specified as coaxial to minimize the potential for HLW leaks into the WPC. The hazard control strategy, passive design feature's safety function, and associated functional requirements for the melter feed cross connect line are adequately described in the PDSA CP.

HLW Facility fires and loss of confinement hazard events can result in spills and spray releases of radioactive and chemically hazardous material in the bulges, potentially affecting the FW. Credited safety controls include the WPC (for confinement and fire separation) and the bulge and associated drain (for confinement and a physical barrier for potential impacts). Direct radiation exposure hazards to the FW credit the WPC and facility structures for shielding. SSCs that have a confinement function are also

designed for natural phenomena (seismic) hazards; these include the transfer and cross connect coaxial piping, bulges, bulge drains, and WPC. The PDSA CP properly identifies the safety function and functional requirements of these credited safety SSCs.

DOE Order 420.1B nuclear safety design criteria include multiple layers of protection to prevent or mitigate uncontrolled release of radioactive materials. The RLD redesign implements multiple layers of defense to prevent or mitigate the release of radiological materials. Robust process piping and vessels provide primary confinement. Coaxial piping applies robust design codes and materials of construction in order to prevent potential HLW releases to the WPC. Piping and in-line components in the bulges are designed and installed using robust materials of construction based on worst-case service conditions. Bulges, bulge drains, and the WPC provide secondary confinement for RLD components. The bulges and WPC areas are maintained at a negative pressure relative to occupied areas by the HLW confinement ventilation system for contamination control and to prevent significant HLW releases into the HLW Facility during a significant event.

The PDSA CP incorporates an adequate hazard control strategy using DiD controls in addition to credited safety controls. A suite of fire separation design features and administrative programs (e.g., fire protection program, procedures and training, conduct of operations, and combustible loading control) adequately control fire hazard events. Controls for loss of confinement hazard events include robust piping and inline components (i.e., components designed for life of the facility), bulge leak detection and alarms, and the bulge vent to the WPC (for overflow) as DiD controls. DiD controls for seismic events include the confinement ventilation system and robust vessel and piping design criteria.

The RLD redesign adequately implements features to facilitate inspections, testing, maintenance, and replacement of safety SSCs as part of a reliability, availability, maintainability, and inspectability program as required by DOE Order 420.1B. RLD piping and vessels include design requirements for the required service conditions. Components inside the WPC are inaccessible and designed to require no maintenance for the 40-year life of the HLW Facility. The bulge allows physical access to active components associated with the RLD (e.g., valves, pumps) for maintenance activities and provides radiation shielding to FW.

The RLD redesign, as analyzed in the PDSA CP, adequately incorporates DOE Order 420.1B nuclear safety design criteria. The PDSA CP appropriately identifies and evaluates safety SSCs needed to control DBAs. The hazard control strategy appropriately uses a DiD approach that provides multiple layers of protection to prevent the uncontrolled release of HLW and low-activity materials. This hazard control strategy adequately includes multiple physical barriers, as well as the minimization of MAR, to control significant hazard events.

5.3 Specific Administrative Controls

Criterion:
Safety analyses shall establish the identification and functions of Specific Administrative Controls (SACs) and the significances to safety of the functions of the SAC. The established hierarchy of hazard controls requires that engineering controls with an emphasis on safety-related SSCs be preferable to administrative controls or SACs due to the inherent uncertainty of human performance. SACs may be used to help clarify and implement an administrative control. (DOE-STD-3009-94)

EA reviewed the PDSA CP to evaluate the RLD redesign impact on the specification of SACs. At this stage of the PDSA design, the control strategy has not fully developed the SACs. Consequently, there was little to review against the DOE-STD-3009 criteria for SACs. The CP removes a provision (i.e., SAC) in the conduct of operations program that controls HLW transfers into RLD-VSL-00008. The

provision allowed off-normal recovery plans for the transfer of HLW concentrate or melter feed (i.e., non-Newtonian HLW) into RLD-VSL-00008 from overflows, spills, or unrecoverable batches. This SAC deletion appropriately reflects the RLD redesign to eliminate all sources of non-Newtonian waste into RDL-VSL-00008. RLD redesign changes did not result in the identification of any new SACs or replacement of safety SSCs with SACs. Other existing administrative controls specified as DiD controls were not modified and no new administrative programs were identified.

5.4 Federal Review and Approval

Criteria:
DOE will review the content and quality of the safety basis documentation. DOE intends to use the approval process to assess the adequacy of a safety basis developed by a contractor to ensure that the public, workers, and environment are adequately protected from identified hazards. (10 CFR 830 Appendix A, section E.2)

DOE will review each DSA to determine whether the rigor and detail of the DSA are appropriate for the complexity and hazards expected at the nuclear facility. In particular, DOE will evaluate the DSA by considering the extent to which the DSA (1) satisfies the provisions of the methodology used to prepare the DSA and (2) adequately addresses the criteria set forth in 10 CFR 830.204(b). DOE will prepare a SER to document the results of its review of the DSA. A DSA must contain any conditions or changes required by DOE. (10 CFR 830, Appendix A, Section F.3)

EA reviewed the SER to determine its adequacy as the approval basis for the RLD redesign PDSA CP, as required by DOE-STD-1104-2014. The SBRT prepared the SER in accordance with ORP procedure TRS-ENS-ENG-IP-01, *Waste Treatment and Immobilization Plant Safety Basis Management*. This procedure establishes the process by which the ORP reviews and approves safety basis documents for WTP nuclear facilities and provides guidance on the review approach, risk acceptance, format, and content of SERs.

The ORP Nuclear Safety Division (NSD) established an SBRT to conduct the evaluation of the PDSA CP submittal and reference material. The SBRT consisted of management, Facility Representatives, nuclear safety specialists from the Nuclear Safety Division, facility engineers, and consultants. SBRT activities included reviews of engineering design and nuclear safety documents, walkdowns of the HLW Facility, and multiple meetings with BNI to discuss comments on the RLD redesign and the associated focused hazards evaluation.

The SER documents ORP acceptance of the PDSA CP and meets the requirements of DOE-STD-1104-2014. The SER concludes that ORP conducted an appropriate review of the PDSA CP and provides the approval bases (i.e., summary review criteria conclusions) for accepting the PDSA CP. The SER appropriately addresses hazard events with unmitigated high or moderate radiological consequences to the public or the co-located worker (CLW), including release of the HLW concentrate receipt stream received from PTF prior to the glass former addition (HLP09). HLP09 is the bounding HLW stream. These hazard events include non-mechanistic fires that spread into the WPC resulting in piping failures, spills and sprays of HLW (in the WPC) resulting from breaches in transfer piping from PTF or the melter cave cross connect, a hydrogen explosion in RLD-VSL-00008, and a seismic event. The SER provides an adequate justification for accepting these events as the unique and representative events for the PDSA CP.

The SER discusses the safety SSCs credited as hazard controls for the updated DBAs with high or moderate consequences to the public or CLW. The SER also evaluates PDSA CP hazard events that resulted in low unmitigated consequences to CLW and public receptors, but high chemical consequences to the FW. These hazard events include spills or sprays of liquids and aerosols of low-activity hazardous

material, comprised mostly of effluent from chemical washes. The WPC and bulges are credited to provide confinement for these hazard events. The WPC is also credited to prevent the spread of fire, to prevent worker access to high radiological environments, and to provide external radiation shielding. The bulge is only credited for preventing high chemical consequences to the FW; it is not credited for FW radiation shielding. The SER appropriately concludes from the PDSA CP that these passive, engineered barriers provide adequate protection for the FW.

The SER also adequately evaluated the changes to credited controls as a result of the redesign. These changes included revising the safety classification of RLD-VSL-00008 from SC to safety significant, as well as deleting the hydrogen mitigation system air purge requirements for RLD-VSL-00008 because the hydrogen explosion hazards had been eliminated.

The SER approved the PDSA CP without any conditions of approval, but identified three discrepancies for BNI to track and close:

- Lack of discussion of the negative impact a failure of the off-gas drains collection vessel would have on the melter off-gas system function
- Lack of rationale for removing an SS control related to overflow lines on breakpots
- Lack of discussion of several unmitigated hazard events in which the initial condition of coaxial piping is credited with preventing the event (e.g., backflow of HLW into the bulge following a leak in the HCP transfer line).

ORP appropriately identified that BNI is in the process of developing a new hazards analysis for the HLW Facility, which will address these discrepancies.

Although thorough in its evaluation of the safety-related design features included in the RLD redesign, the SER does not explicitly discuss the adequacy of DiD provided by the suite of controls, as required by DOE-STD-1104-2014. Since this discussion is not required by the current safety basis review procedure, ORP is revising its procedure to conform to DOE-STD-1104-2014 and has committed to incorporate the requirement for DiD discussion.

The SER adequately documents review of the PDSA CP and provides an understanding of the DBAs, the consequences, and the facility controls incorporated into the RLD redesign to prevent significant hazard events. The SER sufficiently documents the bases (completed review criteria acceptance summaries) for approving the document. The SER also correctly concludes that the revised system descriptions are accurate and consistent and provide enough detail for the reviewer to understand the system and system interactions. The SER appropriately concludes that there is reasonable assurance that the RLD redesign will not adversely affect the health and safety of the public, the workers, and the environment.

6.0 FINDINGS

EA identified no findings during this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified no opportunities for improvement during this assessment.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Review (Hazards Analysis Team Observation): August and October 2014
Document Review: August and November 2015
Comment Resolution: November 2015
Safety Evaluation Report Review and Comment Resolution: March 2016

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Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- CCN: 284093, *Contract No. DE-AC27-01RV14136 – Regulatory Deliverable 9.1 – Preliminary Documented Safety Analysis Change Package for the Redesign of the High-Level Waste Facility Radioactive liquid Waste Disposal System*, October 28, 2015
- 24590-HLW-PDACP-NS-15-0002, *Proposed Changes to the Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information*
- 24590-HLW-HAR-NS-13-0001-07, Rev. 1, *Hazards Analysis Report for High-Level Waste Facility, Volume 7, Radioactive Liquid Waste Disposal System and Autosampling System*, September 24, 2015
- 24590-HLW-RPT-NS-15-002, Rev. 1, *Control Decision Report for High-Level Waste Facility, Radioactive Liquid Waste Disposal and Autosampling System Redesign*. September 24, 2015
- 24590-HLW-PL-ENS-13-0001, *Safety Design Strategy for the High-Level Waste Facility*, Rev. 0, 2014
- 24590-WTP-JCDPI-ENS-13-0001, (Draft) *Redesign of the HLW-RLD System (design, Procurement and Fabrication)*, December 24, 2013
- 24590-HLW-TB-ENG-13-0001, Rev.0, *Engineering Design Decision for HLW RLD*, April 9, 2014
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- DOE/ORP TSR-ENG-IP-01, *Waste Treatment and Immobilization Plant Safety Basis Management*, Revision 7, dated March 31, 2015
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Interviews/Discussions

- HA Team Leader (BNI NSE)
- HLW Nuclear Safety Manager (BNI NSE)
- HLW Process Engineer
- DOE/ORP Nuclear Facility Engineer (NSS)
- DOE/ORP Nuclear Safety Consultant

Observations

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