



Safety Basis Assessment at the Hanford Site Waste Treatment and Immobilization Plant Low-Activity Waste Facility

May 2020

Office of Enterprise Assessments
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Acronyms

BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
CSMP	Chemical Safety Management Program
DiD	Defense-in-Depth
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
LAW	Low-Activity Waste
MAR	Material at Risk
ORP	Office of River Protection
PAC	Protective Action Criteria
SAC	Specific Administrative Control
SBRT	Safety Basis Review Team
SER	Safety Evaluation Report
SMP	Safety Management Program
SS	Safety Significant
SSCs	Structures, Systems, and Components
TSR	Technical Safety Requirements Document
TSRs	Technical Safety Requirements
WTP	Waste Treatment and Immobilization Plant

Safety Basis Assessment at the Hanford Site Waste Treatment and Immobilization Plant Low-Activity Waste Facility

December 2019 – January 2020

Summary

Scope

This assessment evaluated a revision to the Hanford Site Waste Treatment and Immobilization Plant Low-Activity Waste (LAW) Facility documented safety analysis (DSA) and the associated technical safety requirements document (TSR). The assessment also included a review of the safety evaluation report (SER). The DSA uses the methodology of DOE-STD-1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*. The LAW Facility provides for vitrification of low-activity radioactive waste currently stored in the Hanford Site tank farms and is scheduled to start operations in 2023. Implementation of the DSA and TSR is required to be complete in March 2022 to support start of operations in 2023.

Significant Results for Key Areas of Interest

This revision of the LAW Facility DSA complies with DOE-STD-1228-2019, and the TSR follows DOE Guide 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*. The DOE SER complies with DOE-STD-1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*.

Documented Safety Analysis and Technical Safety Requirements Document

This revision of the LAW Facility DSA is the first Departmental use of the methodology in DOE-STD-1228-2019, a successor document to DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis*, for the purposes of developing DSAs for hazard category 3 nuclear facilities.

- Use of this methodology resulted in appropriate reclassification of all chemical hazard controls that had previously been identified as safety significant (SS) structures, systems, and components (SSCs) and specific administrative controls (SACs) to general service SSCs with a unique chemical safety identifier and contractor procedures or programs, respectively.
- The chemical hazards previously controlled by the SS SSCs and SACs are now adequately controlled by a new facility-specific Chemical Safety Management Program (CSMP), which was developed based on the expectations of DOE-STD-1228-2019. One new SAC for control of mercury was identified, the Carbon Bed Media SAC.
- Key safety analysis assumptions regarding radiological and chemical material at risk are protected by SACs.
- The TSR adequately implements the SACs.

Safety Evaluation Report

The SER adequately documents the basis for approving the DSA and appropriately concludes that there is reasonable assurance that the safety and health of the public, workers, and environment will not be adversely affected by operation of the LAW Facility.

Best Practices and Findings

Three best practices are identified in this report:

- Bechtel National, Inc. (BNI) extensively identified and evaluated potential controls for the chemical hazards that were outside the routine scope of the hazardous material protection program in the hazard analysis. This provided a firm foundation for the identification and grading of the CSMP controls in Chapter 18 of the DSA.
- BNI developed a facility-specific safety and health program to protect the safety and health of workers under 10 CFR Part 851, *Worker Safety and Health Program*, and implemented it as the CSMP under 10 CFR Part 830, *Nuclear Safety Management*. Creation of the CSMP allowed control of toxic chemical hazards outside the routine scope of the hazardous material protection program without the need for designating SS SSCs, thereby simplifying the TSR and operational requirements.
- The DOE Office of River Protection (ORP) is maintaining administrative control over configuration management of the CSMP hazard controls. Requiring an ORP-approved “Management of Change” procedure for determining whether the contractor or ORP has approval authority for changes to SSCs required for chemical hazards provides an additional level of assurance that the controls will not degrade over time.

No findings or deficiencies are identified in this report.

Follow-up Actions

No follow-up activities are planned.

Safety Basis Assessment at the Hanford Site Waste Treatment and Immobilization Plant Low-Activity Waste Facility

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Nuclear Safety and Environmental Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of a revision to the documented safety analysis (DSA) and technical safety requirements document (TSR) for the Hanford Site Waste Treatment and Immobilization Plant (WTP) Low-Activity Waste (LAW) Facility. The assessment also included a review of the safety evaluation report (SER) developed by the DOE Office of River Protection (ORP). The revision to the DSA is the first Departmental use of the methodology of DOE-STD-1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 DOE Nuclear Facilities*, which DOE considers an acceptable successor document to DOE-STD-3009-94 Change Notice No. 1, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, for the purposes of developing DSAs for hazard category 3 nuclear facilities. This assessment, conducted from December 2019 through January 2020, is part of a series of ongoing targeted assessments of new DOE nuclear facility projects, focusing on the adequacy of safety basis documents.

This assessment was conducted in accordance with the *Plan for the Office of Enterprise Assessments Assessment of the Waste Treatment and Immobilization Plant Low Activity Waste Facility Safety Basis Addendum at the Hanford Site, May 2016 - May 2020*. EA completed an assessment of the initial issue of the LAW Facility DSA, which followed the methodology of DOE-STD-3009-94 Change Notice No. 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, in May 2018. That assessment, documented in *Office of Enterprise Assessments Assessment of the Hanford Site Waste Treatment and Immobilization Plant Low-Activity Waste Facility Documented Safety Analysis, Technical Safety Requirements, and Safety Evaluation Report – August 2018*, concluded that the LAW Facility DSA met the requirements of DOE-STD-3009-94 Change Notice No. 3 and that the SER provided a defensible approval basis as required by DOE-STD-1104-2014, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*.

In May 2019, DOE issued DOE-STD-1228-2019 as a safe harbor methodology for DSA preparation under 10 CFR Part 830, *Nuclear Safety Management*, for hazard category 3 nuclear facilities. Prior to issuance of DOE-STD-1228-2019, the DOE Office of Environmental Management (EM) issued a memorandum providing implementation guidance for the management of chemical hazards (Memorandum from D. Chung to Distribution, Subject: “Implementation Guidance for Chemical Safety Management,” March 15, 2019). The LAW Facility DSA and TSR revisions incorporate the requirements of DOE-STD-1228-2019 and the additional guidance provided in the EM memorandum. This assessment did not consider the EM memorandum because it is guidance only and not a requirements document. Therefore, consistent with the approved assessment plan, this assessment evaluated only whether the revised DSA and TSR meet the requirements of DOE-STD-1228-2019. The assessment encompassed review of the hazard analysis, hazard controls including safety management programs (SMPs), and the preliminary derivation of technical safety requirements (TSRs). The assessment also included review of the TSR and the approval basis documented in the SER.

Bechtel National, Inc. (BNI), the prime contractor for the WTP design and construction, developed the safety basis documents for the LAW Facility to support a scheduled startup in late 2023. When operational, the LAW Facility will vitrify the low-activity radioactive liquid waste currently stored in the Hanford Site tank farms. The LAW Facility has two melters for vitrification of the radioactive waste and a system for processing the offgas prior to discharge from the facility. Major chemical constituents removed by the offgas system include mercury and nitrous oxides. The molten glass mixture will be

poured into stainless steel containers that will be transferred to the Hanford Integrated Disposal Facility for direct burial.

2.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms “best practices, deficiencies, findings, and opportunities for improvement” as defined in the order. Open issues that have an adequate commitment for closure are identified as “discrepancies.”

Consistent with the assessment plan, this assessment considered requirements for the LAW Facility safety basis documents and Federal review from EA Criteria and Review Approach Document EA 31-35, *Hazard Category 3 Nuclear Facility Documented Safety Analysis and Technical Safety Requirements Criteria and Approach Document*, and DOE-STD-1104-2016.

The methodology of DOE-STD-1228-2019 differs from the methodology of DOE-STD-3009-94 and -2014 in two respects. The first difference is the reduction in requirements for identification, evaluation, and control of radiological hazards based on the limited inventory of radiological material in a hazard category 3 facility. The second is in the identification, evaluation, and control of chemical hazards. Previously, chemicals with known toxicity could not be screened before hazard evaluation. DOE-STD-1228-2019 specifies that chemicals with known toxicity may be screened from hazard evaluation in the DSA if adequately controlled by the scope of a hazardous material protection program meeting the requirements of 10 CFR Part 851, *Worker Safety and Health Program*.

The assessment team focused on changes made in this DSA revision resulting from the use of the methodology in DOE-STD-1228-2019. The members of the assessment team, the Quality Review Board, and EA management responsible for this assessment are identified in Appendix A.

The previous EA assessment report identified four discrepancies that BNI had committed to resolve in the DSA annual update. Three of those discrepancies were previously resolved. The final discrepancy, concerning the maximum allowable water flow rate for the melter feed nozzle cooling water needle valve, required follow-up during the current assessment.

3.0 RESULTS

3.1 Documented Safety Analysis

3.1.1 Hazard Analyses (Chapter 3)

The objective of the assessment of Chapter 3 of the DSA was to evaluate hazard identification and evaluation, including the designation of hazard controls.

3.1.1.1 Hazard Identification

The revised DSA identified a minor difference from the hazard identification criteria used in the previous DSA. Currently, screening of materials with a National Fire Protection Association health rating of 0 or 1 is allowed, while the previous criteria allowed material with a health rating of 0, 1, or 2 to be screened. Items previously screened based on a health rating of 2 were re-evaluated based on the criteria of DOE-STD-1228-2019.

No chemicals were screened from further evaluation in the initial screening; all chemical hazards were carried forward to hazard evaluation and control selection.

3.1.1.2 Hazard Evaluation and Control Selection

All postulated radiological releases resulted in low consequences to workers and the public; therefore, only an initial condition material at risk (MAR) specific administrative control (SAC) for radioactive material was identified.

Chemical hazards, principally anhydrous ammonia, caustic LAW feed streams, sodium hydroxide, and nitrous oxides generated by the LAW melter process, were evaluated, and controls were considered for events that resulted in high or moderate chemical consequences to the co-located worker or public. Prior to control selection, a second screening was performed on chemical hazards using screening criteria derived from DOE-STD-1228-2019 that considered whether the chemical hazard:

- is adequately analyzed/evaluated through 10 CFR Part 851 and controlled by an SMP,
- does not have the potential to initiate or worsen a radiological event,
- does not have the potential to compromise the ability of facility operators to respond to nuclear events, and
- does not have the potential for significant offsite consequences (i.e., exceeds Public Protective Action Criteria level 2, or PAC-2).

In order to facilitate the second chemical screening based on the criteria above, BNI created a facility-specific safety and health program to protect the safety and health of workers under 10 CFR Part 851 using the provision of § 851.23(b), and implemented it as a chemical safety management program (CSMP) under 10 CFR Part 830. The CSMP includes the previous safety significant (SS) structures, systems, and components (SSCs) and SACs for the control of chemical hazards. These SSCs are now considered general service with a unique chemical safety identifier, and the SACs are now contractor-controlled procedures or programs. Creation of this specific program resulted in all chemical hazards being screened from further analysis in the DSA.

The facility-specific safety and health program under 10 CFR Part 851 for the management of chemical hazards, while not specifically identified in DOE-STD-1228-2019, provides adequate control of chemical hazards and meets the intent and requirements of DOE-STD-1228-2019. This approach to managing chemical hazards eliminates all previous SS SSCs and SACs except for the initial condition SAC to control MAR.

The unmitigated evaluation of an aircraft crash into the LAW Facility conservatively concluded that the chemical consequences from the event would exceed PAC-2 to the public. One new control, the Carbon Bed Media Disposal Requirements SAC, was identified to reduce the consequences of mercury exposure from this event; however, a hypothetical concurrent release of anhydrous ammonia, nitrous oxides, LAW feed streams, sodium hydroxide, and mercury from the carbon bed media would still result in chemical consequences exceeding PAC-2 to the public. The residual risk of this event is defensibly accepted by ORP based on the extremely unlikely frequency of the event.

3.1.1.3 Hazard Controls

All previous SS SSCs and SACs for the control of chemical hazards were re-designated as chemical safety controls in the CSMP or removed based on revisions to calculations or the design. The previous LAW Waste Acceptance Criteria SAC for the control of MAR was retained in the DSA and TSR with no changes.

As discussed in Section 3.1.1.2 of this report, one new control for chemical hazards, the Carbon Bed Media Disposal Requirements SAC, is identified as an initial condition MAR control to limit the accumulation of mercury and iodine on the carbon bed media. This ensures that a liquid fuel fire involving the media would not exceed PAC-2 consequences to the public receptor.

3.1.1.4 Defense-in-Depth

No major contributors to defense-in-depth (DiD) are identified as SS, as expected for a hazard category 3 nuclear facility with no identified SS SSCs. Non-credited DiD features suitably include primary and secondary confinement of hazardous materials, cascading airflow, and control systems that provide operator indication of potential hazardous conditions so that preventive or corrective actions can be taken.

3.1.2 Safety Controls (Chapter 4)

The objective of the assessment of Chapter 4 of the DSA was to verify that the functional classification, safety functions, functional requirements, and performance criteria of safety controls are adequate to control the identified hazards.

3.1.2.1 Safety Structures, Systems, and Components

As discussed in Section 3.1.1.2 of this report, application of DOE-STD-1228-2019 eliminated the need for SS SSCs for the control of chemical hazards. The previous version of the DSA included a safety control for the melter feed nozzle cooling water needle valves to restrict flow sufficiently to preclude a melter overpressure condition. The assessment team identified a discrepancy, documented in the previous 2018 EA assessment report, that the supporting calculation did not demonstrate that this safety function would be met. After further engineering study, BNI concluded that this failure mechanism is not possible, eliminating the concern. Therefore, this discrepancy is closed.

3.1.2.2 Specific Administrative Controls

Chapter 4 of the DSA identifies two SACs: the LAW Waste Acceptance Criteria SAC, which is unchanged from the previous revision, and the Spent Carbon Bed Media Disposal Requirements SAC, a new control identified to protect initial conditions and preserve analysis assumptions. For each SAC, an adequate description, safety function, and functional requirements are provided. Additionally, an evaluation section that adequately assesses the ability of the performance criteria to meet their identified safety functions is provided.

3.1.3 Documented Safety Analysis Conclusion

The DSA meets the requirements of DOE-STD-1228-2019 and comprehensively identifies and evaluates the hazards associated with the LAW Facility. The hazard analysis appropriately addresses hazardous materials and energy sources and postulates an adequate set of hazard events. The identified controls are initial condition SACs that are adequate to ensure the safety of workers and the public. The CSMP ensures that chemical hazards are adequately managed under both 10 CFR Parts 830 and 851. The following best practices were identified in the DSA assessment regarding BNI's implementation of DOE-STD-1228-2019:

- BNI extensively identified and evaluated potential controls for the chemical hazards that were outside the routine scope of the hazardous material protection program in the hazard analysis. This provided a firm foundation for the identification and grading of the CSMP controls in Chapter 18 of the DSA. **(Best Practice)**

- BNI developed a facility-specific safety and health program to protect the safety and health of workers under 10 CFR Part 851 and implemented it as the CSMP under 10 CFR Part 830. Creation of the CSMP allowed control of toxic chemical hazards outside the routine scope of the hazardous material protection program without the need for designating SS SSCs, thereby simplifying the TSR and operational requirements. **(Best Practice)**

3.2 Technical Safety Requirements and Their Derivation (Chapter 5 and the TSR)

The objective of the assessment of Chapter 5 of the DSA and TSR was to verify the accurate translation of credited SAC performance criteria into a set of formal, implementable requirements.

The LAW Waste Acceptance Criteria SAC and Spent Carbon Bed Media Disposal Requirements SAC identified in Chapter 5 are correctly categorized as directive action SACs with all identified performance criteria carried forward from Chapters 3 and 4. The TSR accurately reflects Chapter 5 of the DSA and conforms to DOE Guide 423.1-1B, *Implementation Guide for Use in Developing Technical Safety Requirements*.

3.3 Federal Review and Approval

The assessment team reviewed the SER to determine its adequacy as the approval basis for the DSA as required by DOE-STD-1104-2016.

The ORP Safety Basis Review Team (SBRT) reviewed the DSA and TSR and developed the SER in accordance with its approved plan.

The SBRT included appropriate subject matter expertise in necessary disciplines. The SBRT concluded that the DSA adequately implements the safe harbor methodology of DOE-STD-1228-2019 and provides reasonable protection to workers and the public from radiological and chemical hazards resulting from LAW Facility operation. One event, an unmitigated aircraft crash, resulted in PAC-2 consequences to the public. DOE defensibly accepted this risk based on the extremely unlikely frequency of the event. Based on this assessment, the SBRT recommended approval of the DSA and TSR. The SER addresses the approval bases identified for review in DOE-STD-1104-2016, which include base information, hazard analysis, DiD, safety SSCs, SACs, derivation of TSRs, and SMPs. In addition, ORP maintained administrative control over configuration management of the CSMP hazard controls. Requiring an ORP-approved “Management of Change” procedure for determining whether the contractor or ORP has approval authority for changes to SSCs required for chemical hazards provides an additional level of assurance the controls will not degrade over time. **(Best Practice)**

Overall, the SER appropriately concludes that there is reasonable assurance that the safety and health of the public, workers, and environment will not be adversely affected by LAW Facility operation.

4.0 BEST PRACTICES

Best practices are safety-related practices, techniques, processes, or program attributes observed during an assessment that may merit consideration by other DOE and contractor organizations for implementation. The following best practices were identified as part of this assessment:

- BNI extensively identified and evaluated potential controls for the chemical hazards that were outside the routine scope of the hazardous material protection program in the hazard analysis. This provided a firm foundation for the identification and grading of the CSMP controls in Chapter 18 of the DSA.

- BNI developed a facility-specific safety and health program to protect the safety and health of workers under 10 CFR Part 851 and implemented it as the CSMP under 10 CFR Part 830. Creation of the CSMP allowed control of toxic chemical hazards outside the routine scope of the hazardous material protection program without the need for designating SS SSCs, thereby simplifying the TSR and operational requirements
- ORP is maintaining administrative control over configuration management of the CSMP hazard controls. Requiring an ORP-approved “Management of Change” procedure for determining whether the contractor or ORP has approval authority for changes to SSCs required for chemical hazards provides an additional level of assurance the controls will not degrade over time.

5.0 FINDINGS

There were no findings identified as part of this assessment.

6.0 DEFICIENCIES

There were no deficiencies identified as part of this assessment.

7.0 OPPORTUNITIES FOR IMPROVEMENT

There were no opportunities for improvement identified as part of this assessment.

Appendix A Supplemental Information

Dates of Assessment

Document Review: December 2019 – January 2020

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