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History Sheet

Rev	Reason for revision	Revised by
0	Initial Issue	S. Velez / S. Bostock / N. Kippes
1	Incorporation of HLW Project interfacing facilities including Analytical Laboratory. Revision to the Chemical Safety Management Program and Shielding Performance Criteria. Removal of Appendix A - HLW Facility System Matrix. This is a major revision, no change bars are included or required.	S. Velez / N. Peck / N. Kippes
2	Incorporation of LAB Major Modification and update safety strategies as described in the PDSA. Language added to Appendix C.9. Title changed. This is a major revision, no change bars are included or required.	J. Oldenburg

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Acronyms

AA	accident analysis
ACI	American Concrete Society
AGS	American Glovebox Society
ANS	American Nuclear Society
API	American Petroleum Institute
AISC	American Institute of Steel Construction
ALARA	as low as reasonably achievable
AMR	ammonia reagent system
ANSI	American National Standards Institute
ARF	airborne release fraction
ARR	airborne release rate
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASX	autosampling system
AWWA	American Water Works Association
BNI	Bechtel National, Inc.
BOD	Basis of Design
BOF	Balance of Facilities
BR	breathing rate
BSA	breathing service air system
C&O	commissioning and operations
C5V	C5 ventilation system
CBA	cost benefit analysis
CCN	Correspondence control number
CCP	chiller/compressor plant
CD	Critical decision
CFR	Code of Federal Regulations
CHW	chilled water (system)
CIPT	Contractor Integrated Project Team
CLW	co-located worker
CM	Configuration Management
CMAA	Construction Management Association of America
CN	Change Notice
CO	carbon monoxide
COR	Code of record
CS	confined space
CSDR	Conceptual Safety Design Report
CSER	criticality safety evaluation report
CSMP	Chemical Safety Management Program
D&D	decontamination and decommissioning
DBA	design basis accident

DBE	design basis earthquake
DCF	dose conversion factor
DFHLW	Direct Feed High-Level Waste
DFLAW	Direct Feed Low-Activity Waste
DiD	defense in depth
DIW	demineralized water (system)
DOE	U.S. Department of Energy
DOW	domestic (potable) water (system)
DSA	documented safety analysis
DX	direct expansion
EBA	evaluation basis accident
EIE	engineering impact evaluation
EPC	engineering, procurement, and construction
EPCC	engineering, procurement, construction, and commissioning
FCR	facility control room
FHA	fire hazards analysis
FPW	fire protection water system
FW	facility worker
FY	fiscal year
GFR	glass former reagent (system)
HA	hazards analysis
HAR	hazards analysis report
HC-2	Hazard Category 2
HC-3	Hazard Category 3
<HC-3	Less than Hazard Category 3
HCP	HLW concentrate receipt process system
HDH	HLW canister decontamination handling system
HEME	high efficiency mist eliminator
HEPA	high efficiency particulate air (filter)
HFP	HLW melter feed process system
HFO	Hanford Field Office (formerly Office of River Protection)
HID	hazard identification
HLW	high-level waste / High-Level Waste Facility
HMH	HLW melter handling system
HMP	HLW melter process system
HOP	HLW melter offgas treatment process system
HPP	heavy Pu particulates
HPR	Highly Protected Risk
HPS	high pressure steam system
HSHRM	Hanford Site Hoisting and Rigging Manual
HVAC	heating, ventilation, and air-conditioning
HWS	Hanford Weather Station
ICN	integrated control network

ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IHLW	immobilized high-level waste
IPT	Integrated Project Team
ISA	instrument service air (system)
IT&M	inspection, testing, & maintenance
ITS	integral transportation system
Lab	Analytical Laboratory
LAW	Low-activity waste / Low-Activity Waste (Facility)
LFL	Lower Flammability Limit
LPS	low pressure steam (system)
LTE	lighting electrical system
LVE	low voltage electrical system
MAR	material at risk
MCNP	Monte Carlo N-Particle Transport Code
MCR	main control room
MFPV	melter feed preparation vessel
MFV	melter feed vessel
MHS	Hanford Meteorological Station
MOI	maximally exposed offsite individual
MTG	metric tons of glass
MVE	medium voltage electrical
NFPA	National Fire Protection Association
NPH	natural phenomena hazard
NPS	nominal pipe size
NRC	U.S. Nuclear Regulatory Commission
NSE	Nuclear Safety Engineering
ORD	operations requirements document
ORP	Office of River Protection
OSHA	Occupational Safety and Health Administration
PAC	protective action criteria
PADC	Project Archives and Document Control
PC	performance criteria
PCJ	process control system
PCW	plant cooling water (system)
PD	program description
PDOSI	planned design and operational safety improvement
PDSA	preliminary documented safety analysis
PFHA	preliminary fire hazards analysis
PJV	pulse jet ventilation (system)
PPE	personal protection equipment
PPJ	programmable protection system

PrHA	process hazards analysis
PSA	plant service air (system)
PSM	process safety management
PSW	process service water (system)
PT	Pretreatment
PTF	Pretreatment Facility
PVV	process vessel vent exhaust (system)
RD	Requirements Document
RWH	radioactive solid waste handling (system)
QA	Quality Assurance
QAP	Quality Assurance Program
QARD	Quality Assurance Requirements and Description
R&OA	Risk and Opportunity Assessment
RA	requirement area
RF	respirable fraction
RFP	Request for Proposal
RLD	radioactive liquid waste disposal (system)
RPP	radiation protection program
SAC	specific administrative control
SBS	submerged bed scrubber
SC	safety class
SCO	selective catalytic oxidation (unit)
SCR	selective catalytic reducer
SDIT	Safety Design Integration Team
SDS	Safety Design Strategy
SE	safety evaluation
SIH	standard industrial hazard
SIS	safety instrumented systems
SMJ	seismic monitoring system
SMP	safety management program
SRD	Safety Requirements Document
SS	safety significant
SSC	structures, systems, and components
TSR	technical safety requirement
UD	unit dose
UPE	uninterruptible power electrical system
VSD	variable speed drive
WAC	waste acceptance criteria
WAI	waste acceptance impacting
WCSF	wet chemical storage facility
WESP	wet electrostatic precipitator
WStD	worker safety through design
WTP	Hanford Tank Waste Treatment and Immobilization Plant

Executive Summary

This Safety Design Strategy (SDS) documents the planned approach for the integration of safety requirements into the design of the Hanford Tank Waste Treatment and Immobilization Plant (WTP), Project High-Level Waste (HLW) Facility, and facilities that support the operation of the HLW Facility in the Direct-Feed HLW (DFHLW) configuration. This SDS ensures the integration of safety requirements as the DFHLW design is implemented post Critical Decision (CD) -4b through project completion. This SDS is graded for compliance with DOE-STD-1189-2016 and employs the format and content specified in Appendix B of the Standard.

The WTP Project scope includes the HLW Facility, the Low Activity Waste (LAW) Facility, the Analytical Laboratory (Lab), the Pretreatment Facility (PT), and Balance of Facilities (BOF). The LAW Facility and those portions of facilities that support LAW Facility operations in the Direct-Feed LAW (DFLAW) configuration are not within the scope of this SDS. Additionally, the PT Facility is not part of DFHLW and is not included in this SDS. This SDS is developed to support the DFHLW configuration only.

Per the guidance of DOE-STD-1027-92 Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, the HLW Facility is a Hazard Category 2 (HC-2) Nuclear Facility. Although construction for the HLW Project has already begun, from a design and licensing perspective the submittal is being treated as a new facility construction under DOE-STD-1189-2016, *Integration of Safety into the Design Process*. Critical Decision 3 (CD-3) was approved by the DOE (CCN 057394) in April 2003, which authorized full construction for the WTP.

Per DOE-STD-1027-92, the Analytical Laboratory (Lab) Facility, presently configured to operate for DFLAW support, is an existing facility categorized as a less than Hazard Category 3 (HC-3) Nuclear Facility and governed by a Hazards Analysis Report (HAR). To support the increased hazards of DFHLW operations it is anticipated that the Lab Facility will be upgraded to an HC-3 Nuclear Facility. Further, the Lab safety basis will require updates to invoke DOE-STD-1189-2016.

The Project is in the final design with an approved Preliminary Documented Safety Analysis (PDSA) for the HLW Facility, and an approved PDSA for the Lab Facility when operated as an HC-3 facility. The changes in project direction, including the Direct Feed High-Level Waste (DFHLW) approach, changed design approaches that are being managed per a graded approach. This SDS defines the project changes and secures agreement from the DOE with respect to the safety strategy going forward. The PDSAs will be revised for consistency following SDS approval to support the planned design update and finalization process.

The safety design guiding principles of DOE-STD-1189-2016, are implemented herein for the development of the SDS. The "safe harbor" methodology described by DOE-STD-3009-2014 will be utilized in the preparation of a revision to the PDSA for the HLW Facility. The methodology for the Lab Facility when operating to support DFHLW operations is described by DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities*. This SDS identifies key inputs and assumptions (Sections 3 and Section 1.1), safety design decisions and potential risks (Section 9) and expected safety document deliverables (Section 10.2). This SDS contains information on the methodology for conducting hazard analysis and development of the safety basis including specific methodology for atmospheric dispersion. Project codes and standards, with justification for any required tailoring, are submitted as part of this document for approval. Risks and Opportunities are compiled based on the guidance of DOE-STD-1189 for future inclusion in documentation for the HLW Facility including the DSA that ensures the final design is compliant with 10 CFR Part 830, *Nuclear Safety Management.* This SDS proposes a strategy that is mindful of the current DFLAW operations, which when executed as planned will cause minimal interruption to DFLAW operations (See Section 9). Detailed design decisions are included when they impact definition of the safety basis or consequences of the risk management program.

1 Introduction

1.1 Technical Scope

This Safety Design Strategy (SDS) documents the planned approach for the integration of safety requirements into the design of the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Project High-Level Waste (HLW) Facility and facilities that support the operation of the HLW Facility in the Direct-Feed HLW (DFHLW) configuration. This SDS is graded for compliance with DOE-STD-1189-2016 and was developed to define the approach for completing the HLW Project Design and Safety Basis. This SDS is written to ensure the integration of safety requirements as the DFHLW design progresses to project completion. This SDS employs the format and content specified in Appendix B of the Standard.

The WTP Project scope includes the High-Level Waste (HLW) Facility, the Low Activity Waste (LAW) Facility, the Analytical Laboratory (Lab), the Pretreatment Facility (PT), and the Balance of Facilities (BOF). The LAW Facility and those portions of facilities that support LAW Facility operations in the Direct-Feed LAW (DFLAW) configuration of the WTP Project are not within the scope of this SDS. The PT Facility is not part of DFHLW and is not included in this SDS.

At startup, the HLW Facility will utilize a DFHLW configuration as opposed to the baseline configuration that utilized the PT Facility for waste feed receipt and processing activities. Specifically, the baseline configuration received waste from Tank Farms in the PT Facility, where waste would have been divided into high-level and low-activity waste to be transferred to the HLW and LAW Facilities respectively. The DFHLW configuration is anticipated to receive waste from Tank Farms via a waste transfer vault. Additionally, completion of the DFHLW design includes connections to appropriate WTP support facilities (e.g., modification to existing BOF utilities) and infrastructure necessary to implement the DFHLW flowsheet in advance of completing the WTP PT Facility. This SDS is developed to support the DFHLW configuration.

The HLW Facility portion of the Project is in the final design phase with an approved PDSA and is partially constructed. As a result, the approach to this SDS has been tailored to encompass appropriate information based on the project design phase. This SDS forms the high tier safety requirements. The changes in project direction, including the DFHLW approach, will change approaches in design with impacts that will be managed per a graded approach. The HLW Facility is a new facility under DOE-STD-1189-2016, *Integration of Safety into the Design Process*. Per the guidance of DOE-STD-1027-92 Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, HLW is a Hazard Category 2 (HC-2) Nuclear Facility.

Per DOE-STD-1027-92, the Analytical Laboratory (Lab) Facility, presently configured to operate for DFLAW support, is an existing facility categorized as a less than Hazard Category 3 (HC-3) Nuclear Facility and governed by a Hazards Analysis Report (HAR). To support the increased hazards of DFHLW operations it is anticipated that the Lab Facility will be upgraded to an HC-3 Nuclear Facility. Further, the Lab safety basis will require updates to invoke DOE-STD-1189-2016. .

An integrated team from the testing, operations, and maintenance organizations has been embedded within the design organization. This ensures operational requirements, including functional and remotability requirements, are developed and included in the design process for the testing, operability, and maintainability of structures, systems, and components (SSCs). Design requirements will include phases for startup, testing, maintenance, ramp to normal operations, etc., to ensure that the system meets the operating requirements built into the design.

This SDS defines the planned project changes and secures the DOE agreement with the safety strategy going forward. In the event of a conflict in requirements between the HLW PDSA or Lab PDSA and this

SDS the requirements of this SDS take precedence. In addition, a separate SDS has been generated for a theoretical Direct Feed HLW vitrification project and does not define any requirements for the WTP Project.

1.2 Project Scope

The WTP Project scope includes the High-Level Waste (HLW) Facility, the Low Activity Waste (LAW) Facility, the Analytical Laboratory (Lab), the Pretreatment Facility (PT), and the Balance of Facilities (BOF). The LAW Facility and those portions of facilities that support LAW Facility operations in the Direct-Feed LAW (DFLAW) configuration of the WTP Project are not within the scope of this SDS. The BOF support facilities may be modified to support DFHLW design completion. Completion of the HLW Facility design is to include the WTP support facilities (e.g., modification to existing utilities) and infrastructure necessary to implement the DFHLW flowsheet in advance of completing the WTP PT.

The PT Facility is not part of DFHLW and is not included in this SDS.

The Waste Transfer Vault (WTV) is not part of DFHLW and is not included in this SDS. The WTV will be designated as a nuclear facility separate and will not be designed and constructed under the WTP Project or DFHLW Project capital projects.

For clarity the term HLW Project is used in the balance of this SDS to describe the portion of the WTP Project which is not Pretreatment Facility or DFLAW.

Prior to 2023, the HLW Facility used DOE-STD-3009-94 CN3 as the regulatory basis for the HLW Facility safety design strategy. Using that contractually specified regulatory basis, a PDSA was prepared and approved. The HLW Facility PDSA was supported by a complete facility hazards analysis that was consistent with the design maturity.

The current WTP project phase for HLW (i.e., the WTP Project) is at CD-3, and the project has commensurate procurement and construction authority based on this PDSA and project milestone decisions. See section 1.4 for more detail. The WTP Project is planned through 90% design as defined in DOE-STD-1189-2016 for the HLW Facility. During this design phase, the DOE is completing weathering-in the HLW Facility along with some additional limited procurements and construction that promote efficient project execution. The HLW Facility design is being completed to support the recently adopted DFHLW approach instead of considering the earlier feed from the PT Facility.

The HLW Facility hazards are not materially changed by transition to the DFHLW mission, and the controls are generally conservative since the DFHLW feed vector is more benign than previously used for feed from the PT Facility. The changes necessary to implement the DFHLW approach are limited and summarized in this SDS. This SDS was prepared anticipating the DFHLW mission. As changes are implemented this SDS will be revised to increase fidelity and close risks and opportunities as design activities are completed.

Now that the decision to proceed with DFHLW has been directed in Contract Modification 552, the SDS has been modified to explicitly reflect the DFHLW mission. As a result, any gaps with the information that would normally be captured in a CSDR for the new designs and approaches for the HLW Facility will be captured in revisions of the HLW Facility PDSA and hazard analysis that will implement the requirements from both DOE-STD-3009-2014 and DOE-STD-1189-2016, or within this SDS.

This SDS includes a list of items authorized for bid, award, and performance of the design activities in design then build contracts or subcontracts (Section 8.1) in support of DFHLW. All other procurements will require additional approval via a long-lead procurement request (Section 3.5).

Revision 1 of this SDS expands the scope to include the Analytical Laboratory (Lab) as part of the DFHLW project. Informational discussion may be included for interface impacts on the Balance of Facilities (BOF).

The HLW Facility is a vitrification facility using two melters to stabilize radioactive waste products from other facilities at the Hanford site. The facility is served by multiple support facilities (i.e., water, air, backup power) as part of the greater WTP project to support the mission of stabilizing legacy waste products. The hazards in the HLW facility have been evaluated by initial hazard categorization calculation (Section 5.1). Identified hazards currently do not challenge guidance for requirement of Safety Class (SC) controls, the current evaluation is expected to bound the revised results after implementation of the revised feed (refer to Section 9.1 for the strategy on proposed WAC parameters).

The Lab Facility receives and analyzes samples from WTP facilities and processes to support production, safety, and environmental compliance. To service the HLW Facility the design and licensing bases of the Lab Facility is anticipated to be reclassified and managed as an HC-3 facility. To comply with 10 CFR 830, Section 830.7, the "safe harbor" methodology of DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities* will be utilized. This standard is a DOE-approved methodology for meeting the requirements in 10 CFR Part 830, Subpart B, Safety Basis Requirements. For the purpose of preparing DSAs for HC-3 DOE nonreactor nuclear facilities this standard is used as an acceptable safe harbor methodology as set forth in Appendix A to 10 CFR 830 Subpart B.

As a result, the Lab Facility processes, and systems will be discussed in a forthcoming PDSA to a sufficient level of detail necessary to support the hazards and accident analyses. For example, those systems that manage or can affect those that manage hazardous/radiological materials will contain more detail in their descriptions. The level of detail for structures, systems, and components (SSCs) will be commensurate with the mode of operation of the Lab Facility (DFLAW vs. DFHLW) at their most conservative designation. In the PDSA a focus on the design and safety features of SSCs will be presented to further aid in the graded approach, consistent with the requirements listed in DOE-STD-1228-2019.

The SDS is a tool to guide project design, document safety planning, and provide approving authorities sufficient information on which to make decisions. It provides a single source for the safety policies, philosophies, major safety and security requirements, and safety goals for the project. This SDS describes the major hazards anticipated in the facility and how those hazards will be addressed. Any risks associated with the use of new technology or unproved assumptions are identified.

The Lab Facility is presently a less than HC-3 operating facility in support of DFLAW. Lab operates under a formal engineering study or Hazards Analysis Report (HAR) (24590-LAB-HAR-NS-18-001-002 *Analytical Laboratory Hazard Analysis Report to Support DFLAW Operations*). The HAR provides the basis to ensure facility workers (FW) have adequate protection from potential radiological and chemical hazards within the Lab during DFLAW Operations only. To support DFHLW operations the Lab Facility will be operated as a HC-3 facility and will follow DOE-STD-1228-2019 and DOE-STD-1189 2016 for the development of a facility PDSA. This SDS will be revised to incorporate any changes in the safety design strategy and operational plan of the HC-3 Lab Facility.

When the requirements for DOE-STD-3009-2014 and DOE-STD-1189-2016 are implemented for the HLW Facility the HLW PDSA will be renumbered and issued as Revision 0. Similarly, when the requirements for DOE-STD-1228-2019 and DOE-STD-1189-2016 are implemented for the Lab Facility the Lab PDSA will be renumbered and issued as Revision 0.

1.3 Schedule for Key Deliverables

The following near-term key deliverables scheduled as shown to achieve complete implementation of DOE-STD-1189-2016. For additional detail see Appendix B.

- WTP Project SDS Rev 2 Q2 2025
    - Incorporation of design maturity changes
- HLW Facility PDSA DOE-STD-1189 Revision

  - Alignment with DOE-STD-1189-2016 and DOE-STD-3009-2014
  - Implementation of revised ashfall strategy
  - Incorporation of DFLAW lessons learned
  - In alignment with the SDS.
- Lab Facility PDSA DOE-STD-1189 Revision
  - Alignment with DOE-STD-1228-2019
  - Implementation of revised facility design to support DFHLW mode of operation
  - DFLAW uninterrupted mode of operation in parallel with DFHLW support
  - In alignment with the SDS.
- HLW Facility PDSA subsequent revisions or change packages as needed to incorporate updated hazard analysis and safety-in-design progression.
  - Throughout the process, design details and resulting design requirements will be moved from the SDS to the PDSA.
  - In alignment with the SDS.
- HLW Facility Final PDSA – Final revision to align with design complete forecast Q4 2027

Commissioning details and deliverables and potential technical safety requirements (TSRs) will be updated as design progresses. The readiness activities will be developed as the project progresses.

1.4 Project Phase

The current project phase for the HLW portion of the WTP Project is CD-3, and the project has commensurate procurement and construction authority based on project milestone decisions, although the HLW project SDS is being used to limit advance procurements and construction. Consistent with the decision to proceed with the DFHLW approach (as directed in Contract Modification 552), this SDS has been modified to explicitly reflect the DFHLW mission as part of the WTP Project scope, and these changes are to be reflected in HLW PDSA Rev. 0. The HLW PDSA being submitted for approval as a revision 0 document does not indicate that it is being issued for a new project but, provides alignment with the project document numbering convention and because of the significant changes associated with implementation of DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, and DOE-STD-1189-2016, *Integration of Safety into the Design Process*, that were not previously applicable to the HLW portion of the WTP Project.

The decision to proceed with the DFHLW approach resulted in the need for several new and modified support system facilities and systems. These changes are Sections 8 & 9 and are within the WTP Project scope. While significant design effort is still required for these facilities and systems, this situation is acknowledged and acceptable for a project that is in the final design phase with a mature design that is working under a PDSA, as described in DOE-STD-1189-2016, Sections 3.8.3 and B.3. Updates to the HLW Project SDS and PDSA will be provided as the design matures, Appendix B.

The scope of PDSA, Rev. 0, Preliminary Documented Safety Analysis for the High-Level Waste Facility, is limited to the project and technical scope associated with the HLW portions of the WTP Project and this SDS, and does not include incorporation of project or technical scope that is associated with the future DFHLW Project. As a result, the DFHLW Project package having not yet been approved for critical decision (CD)-0/1 by the DOE Office of Environmental Management should not be an impediment to approval of HLW PDSA Rev. 0.

2 Description of Project

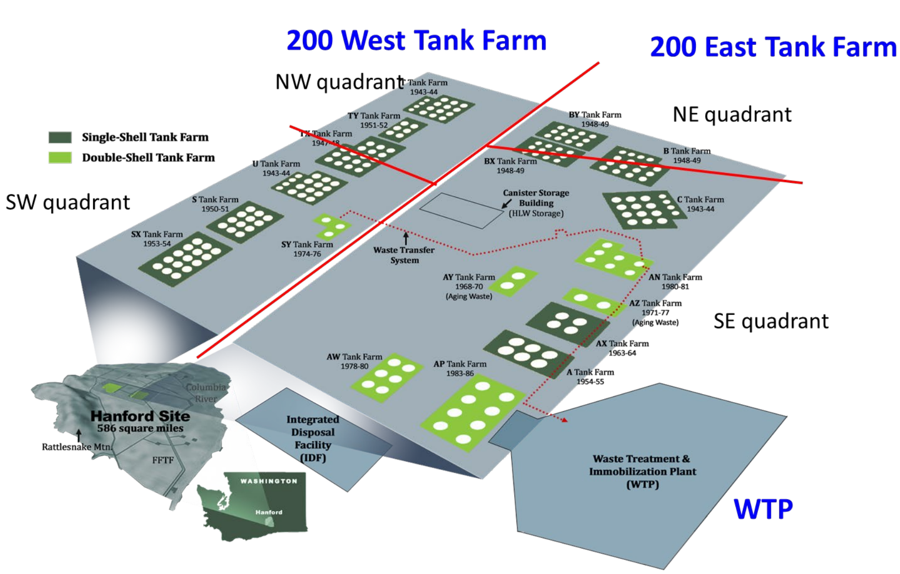
This section provides a description of the Project as pertinent to the HLW and Analytical Laboratory facilities, consistent with the level of knowledge of the project phase. Details include the overall mission, locations, description of major facilities/processes, proposed changes to existing designs and/or constructed builds, and major hazards. Aspects that may be relevant to the overall safety strategy, such as storage capabilities of hazardous materials, waste streams and processes, and support systems and facilities, are also provided.

2.1 Facility Background and Mission

2.1.1 Background

The purpose of the Hanford Site is for managing, storing, and disposing of radioactive and hazardous waste generated from past activities. The Waste Treatment Plant (WTP) site, near Richland, Washington, houses both the HLW and Lab Facilities, processing high-activity waste from 177 underground storage tanks (56 million gallons) at the Hanford Site Tank Farms. These farms, spread across the site, consist of 149 single-shell and 28 double-shell tanks storing liquid radioactive mixed waste from processing irradiated fuel rods. The closest tank farms to the WTP site are the AP, AN, AW, AY, AZ, A, AX, and C farms, with the AP Tank Farm being the nearest. They hold 25 double-shell and 26 single-shell tanks containing liquid radioactive waste. Additionally, the 16 C, AX-102, AX-103, AX-104, and AY-102 tanks have also been retrieved.

Figure 1 Hanford Radioactive Waste Storage and Processing Facilities



The HLW Facility began as a "design-build" project that would allow for procurement and construction to proceed in parallel once sufficient design had been completed. The following represents the sequence of events and approvals leading to the current facility project scope:

- In 2001, Bechtel National, Inc. (BNI) submitted a preliminary construction authorization request to initiate construction of the HLW Facility.

- In June of 2002, the DOE Office of River Protection (ORP) approved initial installation of forms, rebar, and embedments for the HLW Facility basemat, connection of the grounding grid, and placement of basemat concrete (letter 02-AMPD-034/CCN 031977, *Bechtel National, Inc.'s (BNI) Request for Authorization to Commence Construction Activities for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Prior to Preliminary Safety Analysis Report (PSAR) Approval per 10 Code of Federal Regulations (CFR) 830.206*).
- In August of 2002, ORP subsequently approved construction of the HLW Facility walls to grade.
- In November of 2002, full construction of the HLW Facility was approved as documented in letter 02-AMPD-0106/CCN 038711, *Bechtel National, Inc.'s (BNI) Request for Authorization to Commence Construction Activities for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Prior to Preliminary Safety Analysis Report (PSAR) Approval per 10 Code of Federal Regulations (CFR) 830.206 (Forms, Rebar, and Embedments for High Level and Low Level Facility Walls to Grade).*
- In 2005 implemented revised seismic criteria across WTP
- In 2010 completed the External Flowsheet Review Team closing the last major technical issue.
- In 2014 the HLW Facility impacting technical decisions were identified closed based on proposed design changes and proposed testing
- Subsequent direction was received in 2022 via CCN 330976, *Results and Next Steps from the High-Level Waste Facility Scoping Workshop*, authorizing changes to the HLW Facility.
- A U.S. Department of Energy Office of River Protection (DOE-ORP) letter (CCN 286883 [15-NSD-0040], *Waste Treatment and Immobilization Plant Analytical Laboratory Path Forward for Development of the Facility Documented Safety Analysis and Conduct of Startup Readiness Review*) gave direction to WTP to complete a HAR in accordance with DOE O 413.3B, *Program and Project Management for the Acquisition of Capital Assets*. HAR 24590-LAB-HAR-NS-18-0001 *Analytical Laboratory Hazard Analysis Report to Support DFLAW Operations* was created to comply with this direction.
- The scope of the SDS has been expanded to include the Analytical Laboratory as the primary sampling test facility for the HLW Project.

2.1.2 High-Level Waste Facility Mission

The mission of the DOE WTP HLW Facility is to stabilize high activity waste products using joule-heated melters, pour vitrified waste into stainless steel immobilized high-level waste (IHLW) canisters and prepare the full canisters for transportation to a storage facility either on or off the Hanford Site. Eventually, the canisters will be shipped to a federal repository for permanent disposal.

2.1.3 Analytical Laboratory Facility Mission

The mission of the Lab Facility is to provide the required analytical, utility, logistical, and other interfaces needed to support WTP activities, including WTP secondary waste effluent streams (NLD and RLD). The Lab facility will receive waste samples for analysis from the BOF, EMF, HLW, and LAW facilities and from the Tank Farms. In lieu of the PT Facility, the Lab Facility may also receive samples from an intermediary vault in order to support the DFHLW mission.

During DFLAW operations, the Lab provides a service to the LAW Facility, Effluent Management Facility (EMF), and BOF. The samples are comprised of tank farm wastes, treated tank farm wastes (for DFLAW), as-received tank farm wastes, and the prepared LAW feed fraction. The samples will be prepared and analyzed in the Lab Facility and analytical information will be captured, stored, and reported.

During DFHLW operations, the Lab will additionally provide a service to the HLW Facility in the form of diluting and analyzing high-activity samples delivered by the ASX system. The Lab Facility in-cell handling system (LIH) provides the capability for manual movements of samples and waste, including in and out of the hot cells and fume hoods.

2.2 Major Modification Determination

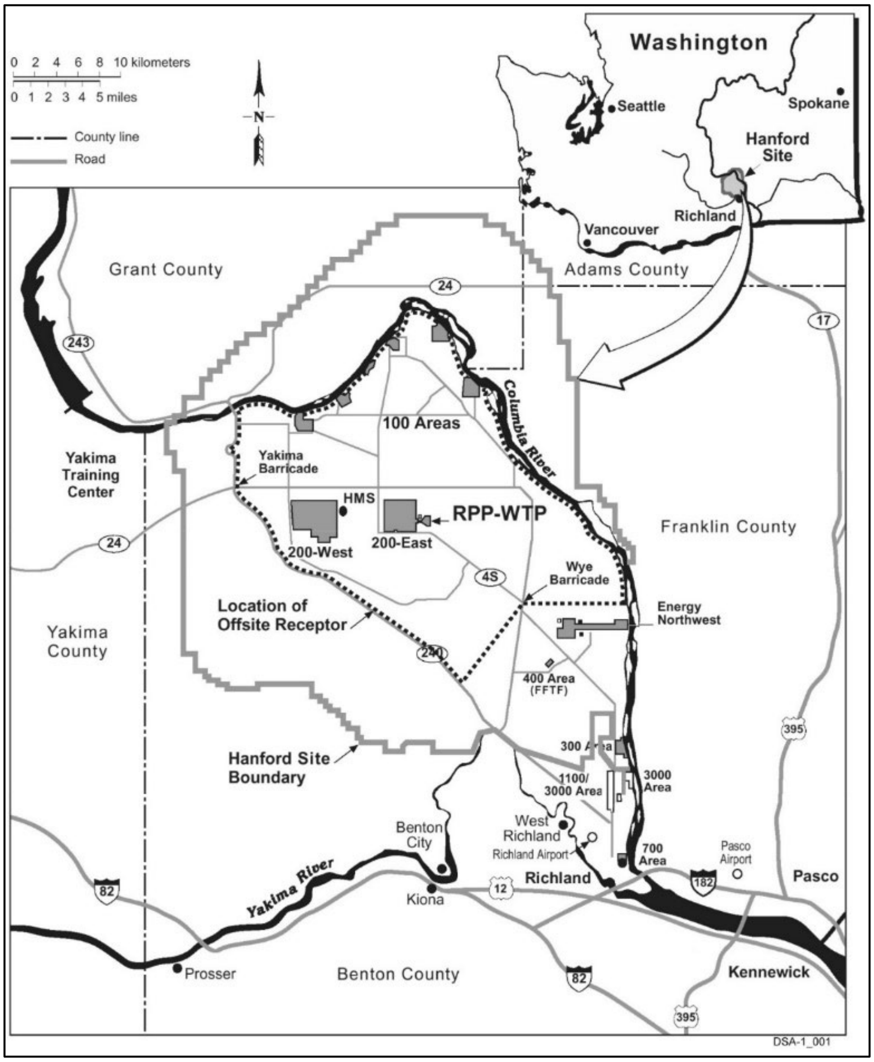
Per the guidance of DOE-STD-1027-92 Change 1, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, the HLW Facility is a Hazard Category 2 (HC-2) Nuclear Facility. Although construction for the DFHLW Project has already begun, from a design and licensing perspective the submittal is being treated as a new facility construction under DOE-STD-1189-2016, Integration of Safety into the Design Process.

Per DOE-STD-1027-92, the Analytical Laboratory (Lab) Facility is an existing nuclear facility currently operated as a less than Hazard Category 3 (<HC-3) Nuclear Facility and governed by a Hazards Analysis Report (HAR). To support the increased hazards of DFHLW operations it is anticipated that the Lab Facility will be operated in alignment with its design and safety basis as a HC-3 Nuclear Facility. A major modification evaluation for the Lab modifications only has been submitted to Hanford Field Office (HFO) in CCN 341177.

2.3 Facility Location

The HLW Facility, and Analytical Laboratory (Lab) are located at WTP on the Hanford Site. WTP is located east of the 200 East area, as shown in Figure 2. The arrangement of WTP facilities is shown in Figure 3. Most of the land within the Hanford Site boundary has limited access under DOE control for use in environmental restoration and remediation efforts.

Figure 2 WTP Location



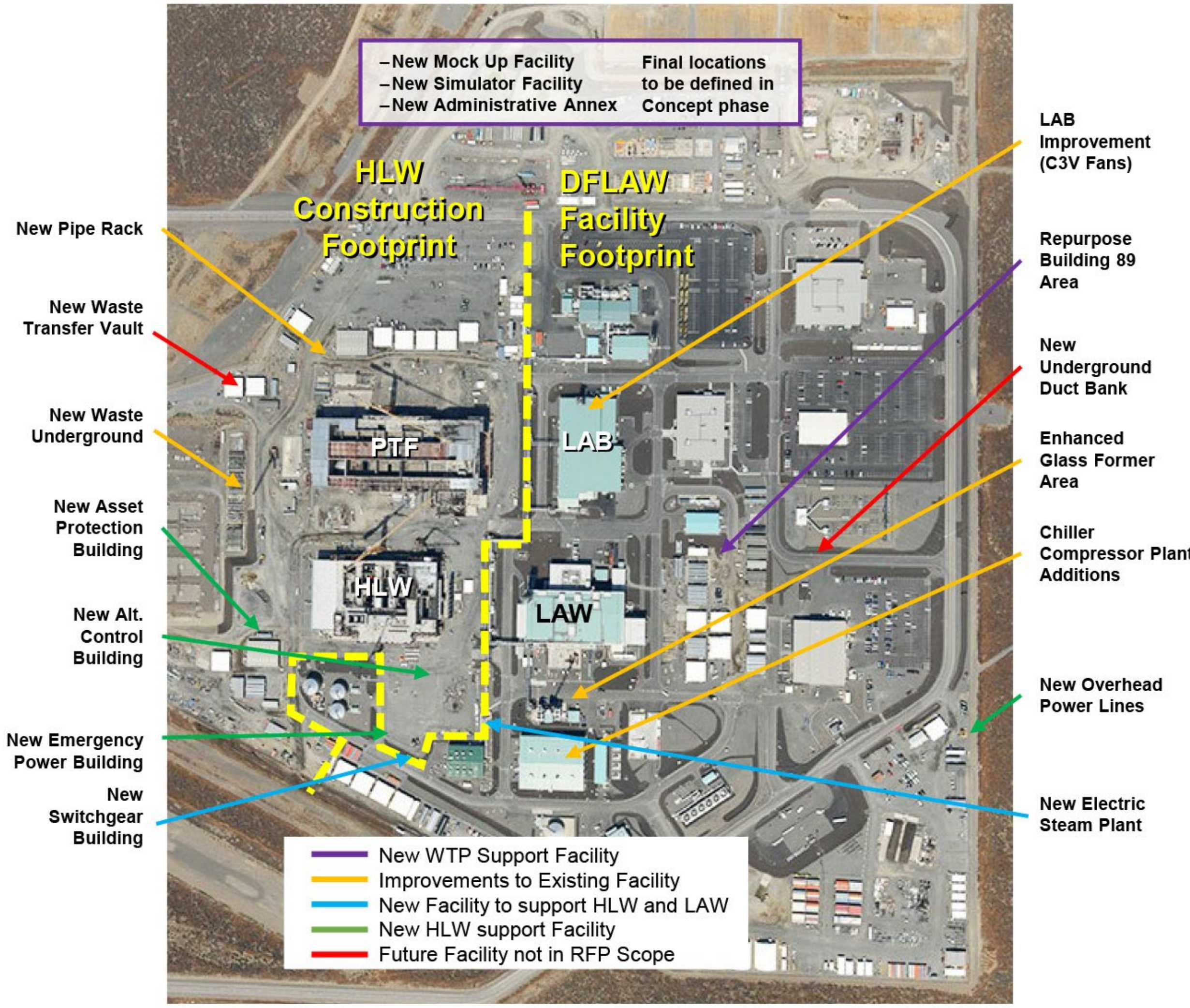
Hanford Site operating areas are identified by area numbers as shown in Figure 2.

The 200 East Area and the 200 West Area are located near the center of the Hanford Site on a relatively flat terrace known as the 200 Area Plateau. The 200 East and 200 West Areas maintain the storage facilities, including 149 large single-shell tanks and 28 large double-shell tanks used to store radioactive and hazardous waste. In addition to the 177 underground storage tanks, other, smaller volume (i.e., less than 50,000 gal) active and inactive underground storage tanks contain small amounts of radioactive and hazardous waste. Several fuel-processing facilities, which are inactive or scheduled for deactivation, are in the 200 Area and cover approximately 6 square miles.

As shown in Figure 3 below, the HLW Vitrification Building (30) is located in the southwest section of the WTP site adjacent to the main DFLAW Boundary. To the south of the vitrification building resides the HLW steam plant, and a planned additional building containing the standby control room, emergency power, and safety air (not shown on the diagram).

Also shown in Figure 3 below, the Analytical Laboratory Building (60) is located in the center section of the WTP site north of the main Law Facility. The Lab building is located within the DFLAW Facility Operating Boundary with interfacing piping planned for sampling from the HLW Facility for use during DFHLW mode of operation.

Figure 3 WTP Facility Arrangement



2.4 Description of Proposed Changes and Impacts to SSCs and Processes

In 2022, the DOE authorized in US DOE Hanford Site letter 22-WTP-002889 (CCN 330976) for BNI to utilize standards DOE-STD-1189-2016 and DOE-STD-3009-2014, to update the safety design basis strategy and to integrate the design and safety analysis work. Associated with the development of the SDS, BNI was also authorized to continue efforts to identify applicable updated codes/standards for the HLW Facility and to identify appropriate grading and tailoring.

As a result of this direction, the HLW Facility work is now taking the opportunity to modernize the design to achieve greater value to the client and to provide an improved facility in all metrics (safety, maintainability, operations, etc.). To achieve these goals the following areas of impact are considered:

- Direct feed of waste to the HLW Facility including revised waste feed parameters (discussed further in 9.1) and glass formulations
- DFLAW Lessons Learned
- Incorporation of Ashfall criteria

- Implementation of design then build methodology
- Modification of the existing approved Lab Facility to accommodate sampling from the HLW Facility (the DSA developed for this use will be developed utilizing standard DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities*)

With the shift to a direct feed approach for the HLW Facility, an alternative for how and from where the feed will be delivered is required. The top candidate for this alternative is a vault, which will receive and process high-level waste from the Hanford Tank Farm. The purpose of the vault is to store, sample, and supply via piping the high-level waste directly to the HLW Facility, ensuring the waste feed is consistent and meets the waste acceptance criteria. The vault alternative must be able to meet the required specifications of the HLW Facility and adherence to strict safety standards. Samples from the vault may be analyzed by the Lab Facility during DFHLW operations if the mission opportunity identified in Section 9 is exercised.

The design and construction of the vault will be managed through a separate contract, emphasizing the importance of this advanced infrastructure in supporting the HLW Facility's waste treatment operations. This specialized facility will play a critical role in the safe and efficient handling of high-level waste, contributing to the overall success and sustainability of the HLW Facility and its mission. Irrespective of the final design solution for direct feed to the HLW Facility from the Tank Farms, the release and exposure of chemical or radioactive hazards will be mitigated to ensure levels to the CLW and the public remain below requirements.

2.4.1 Major Facilities

2.4.1.1 HLW Facility

The main HLW processing facility is a five-story structure, which provides an overall floor space of more than 500,000 ft^2, includes a below-grade level and a Melter Assembly Bay. The processing areas consist of multiple cells and caves connected by transfer tunnels and shielded doors designed to meet confinement and shielding requirements. The cell walls, cave walls, and penetrations are designed to shield workers from direct radiation exposure during normal, abnormal, and accident conditions. The processing areas, in conjunction with active ventilation, provide a confinement boundary to mitigate the effects of releases of material from process equipment. The HLW Facility melter systems are designed to immobilize waste liquids and entrained solids, that meet the waste acceptance criteria, by blending with the appropriate glass formers. The quantity of glass produced is dependent on the composition of the high-level waste incoming streams.

The main process building is predominantly constructed with reinforced concrete and transitions to a braced-frame steel structure above an elevation of 58 ft. An administrative annex building, approximately 50,000 ft^2 in overall floor space (230 ft. × 80 ft.), is attached to the main building and will span three stories without a basement. Within the annex building, various administrative and support functions will be accommodated, including the facility control and HLW melter offgas treatment process system (HOP) equipment downstream of the HOP high-efficiency particulate air (HEPA) filters. The HOP, PJV, and the C5 ventilation (C5V) primary stage HEPA filters will be housed in the filter cave, which will be accessible from an elevation of 14 ft.

The Melter Assembly Bay is to be constructed on the northside of the existing HLW Facility with the function to assemble new melters and temporarily store used melters while in their overpack.

2.4.1.2 Analytical Laboratory

The Analytical Laboratory (Lab Facility) is approximately 200 ft wide, 340 ft long, and 45 ft high, and has areas to support the following main functions: personnel & administrative support, ASX receiving stations for sample carriers from DFLAW and DFHLW, fume hoods for low-activity sample analysis, hotcells for high-activity sample handling, maintenance & tooling storage, mechanical & utility areas (ventilation, electrical, gases and water supply), liquid effluent management, bulk storage of liquid nitrogen/argon, helium/air pressurized containers/bottles, and waste management areas for packaging.

The Lab Facility receives samples by two methods:

- The autosampling system (ASX), the primary method of sample receipt from the other WTP facilities, uses pneumatically driven sample containers through tubes between the facilities. High-activity samples from the HLW Facility are sent to the hot cell at the Lab Facility. Low-activity samples from the LAW are sent to a fume hood at the Lab Facility.
- The laboratory in-cell handling system (LIH) provides the capability for manual movements of samples and waste, including in and out of the hot cells and fume hoods.

The analytical hot cell laboratory provides the capability to perform analyses in support of production facilities on samples with high radiation dose rates, primarily for the HLW Facility. The analytical equipment and operations in the hot cells are used for the following purposes:

- Receive and track samples from the HLW, and Hanford Tank Farms
- Prepare samples for analysis
- Analyze samples for the required constituent concentrations
- Report analytical information to users

The Analytical Radiological Laboratory system (ARL) consists of 14 different radiological areas with the Lab Facility. The ARL, also called the radiological laboratories, houses the fume hoods, equipment, storage space, reagents, and other items necessary to support low-activity sample analysis activities. The scope of the ARL consists of the function and operation of fume hoods, sample storage cabinets, and description of equipment layout in the Radiological Laboratories (RL 1-13). It does not include the laboratory structure or mechanical handling systems. The ASX system delivers samples to the radiological laboratories. Diluted HLW samples from the hot cell are manually transferred from the hot cell bay to the radiological laboratories.

The Analytical Laboratory performs analysis on waste and products to ensure compliance with process and IHLW requirements. The Lab Facility is in partial operations to support DFLAW. The WTP Vitrification Project, and pertinent components of the Lab Facility, includes piping and systems within the HLW Facility building and connections to the BOF services. This scope includes:

- Waste transfer lines from radioactive liquid waste disposal (RLD) system to the HLW Facility boundary (i.e., at the outer wall penetration)
- Autosampling system (ASX) sample line to the Analytical Laboratory (Lab) boundary (i.e., at the outer wall penetration)

The major facility subdivisions for the Lab Facility are as follows:

- Analytical Radiological Laboratory (ARL): receipt, handling, analysis, and storage of samples from the LAW Facility, EMF, or an equivalent Tank Farms sample

- Radioactive liquid waste disposal (RLD) support to ARL: transfer, storage, and dilution of ARL (low-activity) waste samples
- Analytical hotcell laboratory (AHL): receipt, handling, analysis, and storage of samples from the HLW Facility and potential future Vault (see Section 9 Risks & Opportunities) or an equivalent Tank Farms sample
- RLD support to AHL: transfer, storage, and dilution of AHL (high-activity) waste samples
- RLD sampling for non-radioactive demineralized water (DIW) system water chemistry

Radioactive solid waste handling (RWH): handling, storage, and transfer of Lab-generated solid radioactive waste

2.4.2 Support Systems and Facilities

The HLW facility utilizes a number of support facilities and support systems to operate. The facility requires utilities (water, air, power, steam) as well as process inputs (glass formers, wet chemicals).

A summary of support systems and facilities are shown in Table 1.

Table 1 Systems & Facilities

Support System/Facility	Function	In HLW Facility Boundary?
Wet chemical storage facility (WCSF)	A storage facility for nitric acid, sodium hydroxide, and cerium nitrate that will be supplied to the HLW Facility.	No
Chiller/Compressor Plant (CCP)	Supplies BOF Plant Service Air (PSA) and Chilled Water (CHW). This facility uses a combination of rotary screw compressors with Variable Speed Drives (VSDs) sized to meet the demands of the user facilities.	No
BOF Steam Plant & HLW HPS / LPS Systems	The BOF steam plant provides high-pressure steam to WTP facilities, including the HLW Facility. A continuous supply of 135 psig saturated steam is supplied to WTP facilities from the steam plant in an above-ground piping system. The HLW HPS system supply line enters at the northeast corner of the facility. The HLW HPS and LPS systems supply steam for process and decontamination use in the HLW Facility. The high-pressure steam applications consist of steam process, heat exchangers, transfer ejectors, vessel heating, and decontamination/flushing applications.	No
Glass Formers Reagent System (GFR)	Glass former material is received, stored, prepared, and delivered to the HLW Facility for vitrification activities. Batches of GFRs are sent from the BOF glass former storage facility by pneumatically conveying them into one of two receipt blending hoppers in the HLW Facility. Enhanced Waste Glass (EWG) formers are added in the feed receipt vessel at different compositions based on sample results of the waste feed received. EWG is a revised glass model that determines the amount of glass forming chemicals to add to the Melter Feed Preparation Vessel (MFPV).	No
Emergency backup power UPE & SDX	Upon loss of normal power supplies electrical power for medium and lower voltage of acceptable quality with minimal delay to the HLW Facility. Facility electrical power distribution is supplied from the Uninterruptible Power Electrical System (UPE) and Standby Diesel Generator System (SDX)	No
Standby Control Room	In the event that the HLW FCR is temporarily uninhabitable, the required control and monitoring functions of the HLW Facility are managed from the HLW Standby Control Room.	Yes

Support System/Facility	Function	In HLW Facility Boundary?
Normal Operating Power (MVE / LVE)	Offsite power is provided to the WTP site from the site services electric utility. The HLW Facility electrical power distribution system is supplied from four 13.8 kV feeders to the Medium Voltage (13.8/4.16 kV) Electrical System (MVE) & Low Voltage (480/208/120 V) Electrical System (LVE)	No
Water supply (DIW, DOW, CHW, PSW)	Water is supplied via the Demineralized Water System (DIW) as an initial fill & makeup water to closed secondary loops used to cool certain process-related components, provide for maintenance activities (losses due to blowdowns), as well as support the operation of certain process equipment such as the wet electrostatic precipitator (WESP). The DIW system treats process service water (PSW) to produce demineralized water. Potable water is also supplied to the HLW Facility via the Domestic (Potable) Water (DOW) System. Chilled Water System (CHW) supplies the HLW Facility contamination ventilation cooling systems, canister storage area ventilation exhaust system, and room fan coil units.	No
Safety Cooling Water	Preliminary design was a support system that has two cooling loops that supply safety cooling via safety significant (SS) air conditioning units (ACUs) in multiple rooms throughout the HLW facility. The purpose of the SS ACUs was to maintain the required temperatures in the C1, C2, and C3 rooms containing safety related equipment during Design Basis Events (DBE). Work on this design of the Safety Plant Cooling Water System (PCWX) has been discontinued while alternative safety cooling strategies which would not require a safety cooling water system are pursued.	Yes
Plant Cooling Water (PCW) System & Cooling Towers	The function of the PCW system is to provide cooling water to cool the process vessels, process equipment, melters, melter power supplies, and the melter power supply output transformers. The system originates from a BOF cooling tower facility that supplies process water to the WTP process facilities and the Lab.	No
Plant Service Air (PSA) & Instrument Service Air System (ISA)	The HLW ISA system is a distribution piping network that receives air, reduces the supply pressure, maintains a reservoir of compressed air to accommodate load fluctuations, and supplies compressed air to designated equipment, instruments, and other end users located throughout the HLW Facility. The system receives air from the BOF PSA system and a secondary safety designated air supply system (if required). The BOF PSA system supplies normal air and the safety air PSA system supplies highly reliable backup air. Instrument service air refers to plant service air that has been conditioned (dried and cleaned) for delivery to instruments. Supporting system to existing and future control systems. The HLW safety ISA system reduces the probability of a release of radioactive and chemically hazardous materials by providing a reliable source of instrument air to selected SSCs, available during abnormal and accident conditions. Safety monitoring and control functions of the safety instrument air system are implemented by the PPJ. This utility was originally designed to be housed in the PT Facility but is now planned to be supplied via a DFHLW alternate.	No
HLW Mockup Facility	The mockup facility provides ability to simulate facility operations in support of training and demonstration/feasibility of off-normal conditions.	No
Asset Protection building	Provides non-safety support utilities to reduce the likelihood of damage to facility equipment during extended loss of site power. This facility is strictly non-safety, any safety systems requiring utilities during NPH are serviced through other means.	No

Support System/Facility	Function	In HLW Facility Boundary?
HLW Annex Structure	The HLW Annex Structure contains the HLW Facility control room (FCR), administrative offices, and portions of the secondary offgas treatment systems that support the main building's processes. The annex building houses support functions including the HLW melter offgas treatment process system (HOP) equipment located downstream of the HEPA filters.	Yes

2.4.3 Process Systems Changes due to DFHLW

Impacts to process systems due to direct feed to the HLW Facility are summarized in Table 2.

Table 2 Anticipated Impacts to Process Systems

System	Description	Impact
HFP/HCP feed receipt lines	Vessels in the facility receive waste feed from a source external to the WTP boundary.	Delivery location and design parameters may require revision to accommodate the change to direct feed.
Melter Offgas (HOP)	Collects the offgas from the melter and process vessel vent systems and treats the resulting offgas stream to remove radionuclides and hazardous chemical components prior to discharge to the environment. Also maintains a negative pressure throughout the system to provide confinement of the offgas stream within the facility.	Increased supernatant being sent to the HLW Facility for processing requires modifications to the offgas treatment system and possible changes to the stack extraction fans. The selective catalytic oxidation and reducer (SCO/SCR) units may need to be resized.
Liquid effluent	Facility processes liquid effluent is collected in vessels and sent outside the facility for processing.	Previously the liquid effluent returns were to be processed at the PT Facility and will now require a new location.
PPJ	Primary logic solver for the HLW Facility safety instrumented systems (SIS). Serves as the logic solver for the majority of safety functions. The PPJ system is an integrated hardware and software system.	Design and process condition changes and associated interfaces will drive needed changes and updates to the PPJ.
Facility control	Provides a centralized monitoring and control location to utilize the capabilities of the process control system (PCJ).	Facility changes, new support facilities and interfaces, removal of the PT Facility, etc., will all have an impact on connections to and monitoring from a control room.

Table 2 Anticipated Impacts to Process Systems

System	Description	Impact
ASX	The function of the ASX system is to remotely transfer sample containers pneumatically to the hot cell or fume hood sample receipt areas in the Lab for testing. The ASX system is not exclusive to the HLW Facility; it can also manage samples from a DFHLW alternate location (vault) that has yet to be fully specified and the LAW Facility. The facility ASX systems are unidirectional and not tied directly to each other; therefore, samples can only be sent to the Lab and not between facilities. With this configuration cross-facility interactions in this are not possible. The HLW Facility will share the sampler and receipt portion of the ASX system in the Lab; therefore, samples can be sent from only one facility at a time.	Design changes to Analytical Laboratory to support DFHLW operations are not anticipated to have an adverse impact on existing operating modes (Baseline and DFLAW) however they will be evaluated to ensure compliance with any changes in facility hazard categorization.

Figure 4 Flow Diagram of the DFHLW Facility Processes

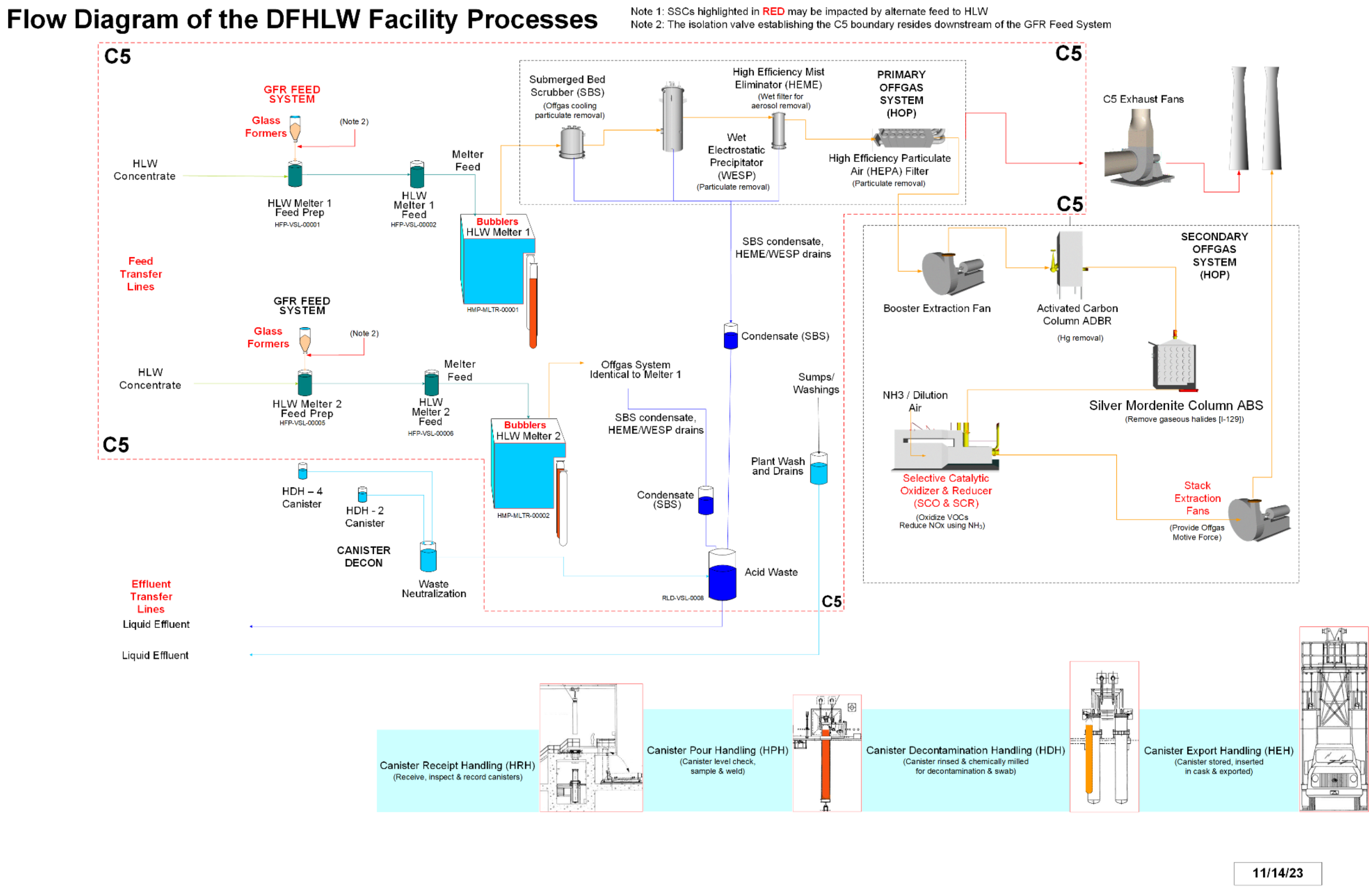
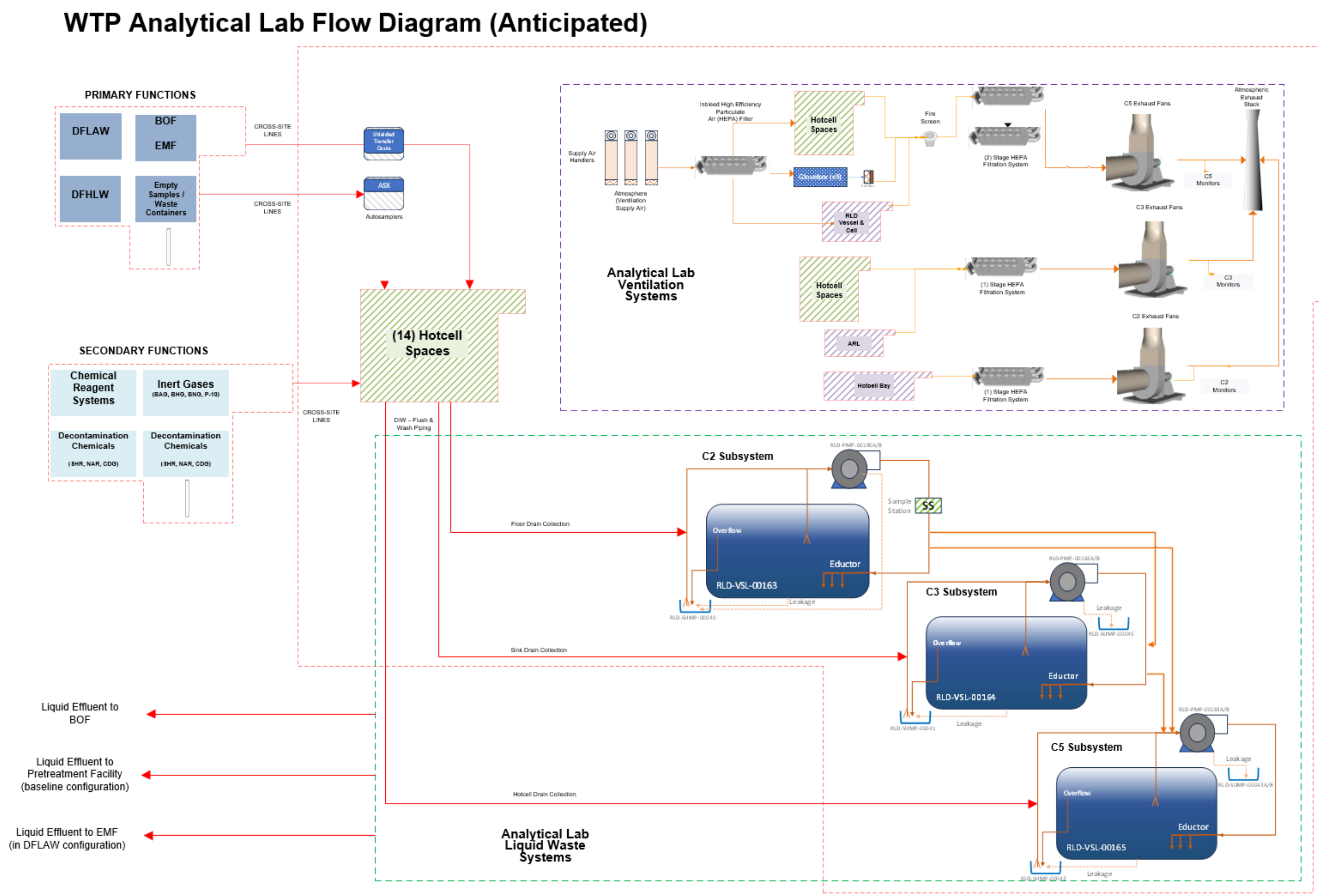


Figure 5 Flow Diagram of the Analytical Laboratory Processes



The planned process begins with high level waste originating from Tank Farms being transferred using underground lines to receipt vessels in a newly proposed vault. In order to effectively manage the high level waste transfer between the Tank Farms Double Shell Tanks and the High Level Waste Treatment facility an intermediary facility is planned to stage waste and receive effluents being returned to the Tank Farms.

After receipt into the HLW Facility, two parallel processing systems are used to further prepare the waste for the two melters. Although not strictly redundant, feed can be transferred from one melter feed train to another in order to provide a way to empty feed vessels whenever a specific train is offline.

The vessels, pumps, transfer piping, etc. used to accomplish those operations are included in the HLW concentrate receipt process system (HCP) and the HLW melter feed process system (HFP) where glass formers are added. Next, the waste with glass formers is transferred into the joule-heated melters of the HLW melter process system (HMP) where the waste slurry is converted to molten glass and offgas. Each of the original melters has a design capacity of 3.0 MTG/day. The HLW Facility will be capable of supporting a mission production capacity of up to 7.5 MTG/day with replacement melters.

Autosampler units for the HLW Facility are in rooms at elevation +37 ft. The Autosampling System (ASX) remotely collects samples from process locations and transfers the sample containers pneumatically to the Lab Facility for testing. The facility ASX systems are not tied directly to each other, and therefore, samples can only be sent to the Lab Facility and not between facilities. A single pneumatic transfer line, which is part of the HLW Facility, is used by three ASX system autosamplers to deliver samples to the Lab Facility. When the transfer line reaches the penetration, it becomes part of the Lab Facility. Recirculation piping delivers vessel contents to the ASX system. For two of the autosamplers the waste is mixed in the vessels using mechanical HFP agitators prior to sampling. For sample collection, the melter feed vessel (MFV) transfer pumps recirculate slurry through an ASX bulge, where a sample is collected and pneumatically transferred to the Lab for analysis. The HLW Facility radioactive liquid waste disposal system (RLD) also sends samples to the Lab Facility for analysis via the ASX system.

The HLW ASX system plays a critical role in ensuring the quality and safety of the materials processed within the HLW Facility. This system is designed to automate the sampling process, which is crucial for analyzing and monitoring the properties and composition of the waste materials being processed. The system comprises three autosamplers. These are automated machines equipped to handle the sampling process without the need for manual intervention, improving efficiency and reducing the risk of contamination or exposure to hazardous materials.

Each autosampler is connected to various components necessary for extracting samples from the process vessels. When the need for a sample is identified for one of the HLW sample stations, a carrier with an empty sample bottle is dispatched from the Lab carrier dispatch station to the appropriate HLW autosampler. The equipment in the sample station extracts the empty bottle, fills it with material from the process, and returns the filled sample bottle to the carrier. The carrier with the filled sample bottle is dispatched back to the Lab for the appropriate analysis. The HLW Facility glass samples are not transferred via the ASX system.

The molten glass is discharged from the melter into a stainless-steel IHLW canister where it is allowed to cool before a canister lid is installed. The canister is then decontaminated in preparation for transportation to a storage facility either on or off the Hanford Site. Eventually, the canisters will be shipped to a federal repository for permanent disposal.

Four canister handling systems are used to receive new canisters, transfer canisters into and out of the HLW pour caves, place them under the melter pour spout to receive the molten glass, close and decontaminate the canisters, and prepare them for disposal.

Offgas generated during the vitrification process must be removed from the melter plenum to prevent over pressurization. This is accomplished using the HLW melter offgas treatment process system (HOP) which actively vents the melter plenum using negative pressure developed by system offgas exhaust fans. The offgas is confined and treated to meet applicable environmental requirements before it is directed out through the HLW Facility stack. HOP is comprised of two sections. The first is the primary offgas system located within the C5 boundary which cools, condenses, and removes radioactive particulate from the offgas stream. The second is the secondary offgas system located outside the C5 boundary which removes chemical contaminants along with a small amount of radioiodine. The process vessel vent system (PVV) collects the vent stream from the connected process vessels and routes it to HOP where the vent stream mixes with the offgas stream and is treated with the melter offgas. Anhydrous ammonia is supplied to the HLW Facility by the BOF ammonia reagent system (AMR) for use in the HOP secondary offgas system for oxides of nitrogen (NOx) abatement.

Treatment of the offgas includes the following steps:

1. Cooling and passing through an aqueous submerged bed scrubber (SBS) and a wet electrostatic precipitator (WESP) to remove aerosols and particulates.
2. Passing through a high efficiency mist eliminator (HEME) and primary and secondary HEPA filters with preheaters to provide the final removal of the radioactive particles.
3. Passing through activated carbon adsorption units to remove mercury, silver mordenite columns to remove radioiodine (I-129) and other halides, and catalytic oxidizer units to remove volatile organic compounds.
4. Nitrogen oxides are reduced to nitrogen and water by selective catalytic reducer (SCR) units before being emitted into the atmosphere.

Radioactive liquid waste and effluents are generated from vitrification and support processes. The HLW radioactive liquid waste disposal system (RLD) is used to manage that material. The RLD effluent is eventually transferred back to the Tank Farms for future processing.

Selected areas in the building are equipped with direct expansion (DX) cooling units connected to an outside air-cooled condensing unit. Temperature instrumentation on each DX cooling unit monitors room temperatures to maintain local area temperatures within equipment qualification requirements. The DX cooling system design may change as HLW Facility design progresses.

2.4.4 Operations and Control Systems

The operation of the HLW Facility involves a range of activities such as control room operation, instrument and control calibration, equipment/facility maintenance, repairs, crane operations, and radiation protection and control, among others. Some of these operations require operator action and are carried out remotely.

Process control is provided through an integrated control network (ICN) with safety control provided by the programmable protection system (PPJ). Monitoring systems are provided for radiological protection and to evaluate atmospheric conditions inside the HLW Facility. The ICN also monitors the stack discharge to verify compliance with Washington state and federal limits.

The ICN plant-wide controls systems consist of programmable electronic systems and human-machine interfaces; their primary function is to assist plant operations personnel in the startup, monitoring, control, and planned shutdown of the plant. The ICN is the plant-wide control system responsible for process operations and alarm and notification functions. The ICN also interfaces with the Hanford Tank Farms.

The PPJ system is the primary logic solver for the HLW Facility safety instrumented systems (SIS). The PPJ system is an integrated hardware and software system. The process, mechanical, and ventilation system sensors and final elements connected to the PPJ system are credited functions but are not a part of the PPJ system. The primary function of the PPJ system is to serve as the logic solver implementing the safety instrumented functions (SIF) required for the HLW Facility process, mechanical, and ventilation systems. The PPJ system performs its protective functions by obtaining external inputs from the process, performing logic solving based on these inputs, and generating output signals to allow final elements to respond in a way that places the process in a safe state. The SIS (including the PPJ) is designed to fail to a safe position if any part of the SIF were to fail. The PPJ systems in the HLW Facility contain redundancy as needed to achieve safety categorization or as needed to support hazards analysis events.

An Operations Requirements Document (ORD) provides an outline of the operations and maintenance philosophy, as well as the requirements that are necessary for the entire lifecycle of the HLW Facility. Specific operations and maintenance activities for HLW Facility systems will be addressed in the HLW Facility system description documents.

The control system for the HLW Facility includes the HLW Facility control room, standby control room, crane control room, cave face control, and other local control stations, which will be described in the HLW Facility PDSA (24590-HLW-PDSA-NS-24-0001). The location of the main control room for the HLW Facility in Direct Feed operation will need to be determined in the absence of the PT Facility.

For the Lab Facility, selected instrument data is provided in the LAW Facility control room. There is no dedicated control room within the Lab Facility for managing lab incidents. The Lab Facility does not have a centralized monitoring system. Individual system components provide alarms in the LAW control room and local alarms in the Lab Facility itself.

Room A-0113 provides a dual function, acting as an office area for Lab shift technicians and as the standby control room for DFLAW operations, if and when required. Other than standard computer terminals, no additional equipment is required for lab personnel. As demonstrated in the existing hazards analysis report assessments, no significant hazards are associated with Room A-0113 in its use as an office area or as the standby control room for DFLAW operations. This is not anticipated to change when the Lab Facility is used to support DFHLW operations.

2.4.5 Major Hazards

Major hazards are associated with the waste feed process slurry, melter, offgas system, transportation and storage of high-level radioactive waste canisters, and the processing of secondary waste (liquid and solid) generated during the vitrification process. The handling and management of hazardous radioactive and chemical materials pose risks to workers, the public, and the environment.

Safety strategies for both the HLW and Lab Facility hazards are discussed further in Section 5 of the SDS. The following are the major hazardous materials associated with the DFHLW Project:

- Liquid Waste Feed (Radiological and Chemical Hazard Constituents)
- Molten Glass (Radiological, Chemical Hazard Constituents, and Thermal Hazards)
- Melter Offgas (Radiological and Chemical Hazard Constituents)
- Solid Secondary Waste (Radiological and Chemical Hazard Constituents)
- Liquid Effluents (Radiological and Chemical Hazard Constituents)
- Ammonia Gas (Explosive Hazard)
- Sodium Hydroxide (5M) (Chemical Hazard)
- Cerium Nitrate (0.5M) (Chemical Hazard)
- Nitric Acid (2M) (Chemical Hazard)
- Mercury (Chemical Hazard collected on Carbon Bed)
- Hydrogen Generation (Explosive Hazard)

- Anhydrous Ammonia (Chemical Hazard)
- Steam (Industrial Hazard)
- Process Gases (e.g., Argon, Nitrogen) (Chemical Hazard)
- Electrical (Industrial Hazard)
- Pressurized liquids (Industrial Hazard)

Detailed hazards are discussed in Section 7.

2.4.5.1 HLW Facility Hazards

The HLW Facility is a Hazard Category 2 (HC-2) Nuclear Facility in accordance with 10 CFR 830, *Nuclear Safety Management*, Subpart B, Section 830.202, and DOE-STD-1027-92 Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, guidance.

The HLW Facility is designed with active confinement ventilation systems. The passive C5 confinement boundary provides secondary confinement of released radioactive and chemically hazardous materials and directs released materials to the active confinement ventilation system. The C5 boundary also provides shielding for and prevents access to areas of the facility with the highest radiological and chemical hazards. The majority of the facility's material at risk (MAR) is within the C5 boundary such that the boundary along with the active ventilation system is the primary means of controlling most of the facility hazards.

2.4.5.2 Analytical Laboratory Hazards

The hazard categorization (HC) process (24590-LAB-U4C-60-00003, *Hazard Categorization for the Analytical Laboratory for DFLAW Only Operations*), determined that the Lab Facility operates as a less than hazard category 3 nuclear facility (<HC-3) during DFLAW operations. This determination was found to be compliant with 10 CFR 830, *Nuclear Safety Management*, Subpart B, Section 830.202

The Analytical Laboratory when supporting DFHLW operations is anticipated to be a Hazard Category 3 (HC-3) Nuclear Facility in accordance with 10 CFR 830, *Nuclear Safety Management*, Subpart B, Section 830.202, and DOE-STD-1027-92 Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, guidance.

The Lab has been designed to provide analytical services to all other WTP facilities and may also be utilized to handle samples from non-WTP adjacent facilities. Before receipt of non-WTP samples, project documents including this SDS would require updates to quantify the impact and hazard presented to WTP. During WTP Baseline operations (as defined in 24590-WTP-PSAR-ESH-01-002-06, *Preliminary Documented Safety Analysis to Support Construction Authorization; Lab Facility Specific Information (PDSA)*, the Lab Facility was originally designed to provide a service to the Pretreatment (PT) Facility, High-Level Waste (HLW) Facility, Low-Activity Waste (LAW) Facility, and Balance of Facilities (BOF). At this time there are no longer plans for the Lab Facility to provide a service to the PT Facility but it will continue to provide services to all of the aforementioned facilities.

The Analytical Laboratory is designed with active confinement ventilation systems. The passive C5 confinement boundary provides secondary confinement of released radioactive and chemically hazardous materials and directs released materials to the active confinement ventilation system. The C5 boundary also provides shielding for and prevents access to areas of the facility with the highest radiological and chemical hazards. The majority of the facility's material at risk (MAR) is within the C5 boundary such that the boundary along with the active ventilation system is the primary means of controlling most of the facility hazards.

Safety strategies for these hazards are discussed further in Section 5 of the SDS. Detailed hazards are discussed in Section 7. The following are the major documented hazardous materials associated with the Analytical Laboratory for DFLAW and Baseline modes of operation (as defined in the HAR document 24590-LAB-HAR-NS-18-0001), as well as the anticipated hazards for when the Lab Facility supports DFHLW:

DFLAW Mode:

- Liquid Waste Feed (Radiological and Chemical Hazard Constituents)
- Solid Secondary Waste (Radiological and Chemical Hazard Constituents)
- Liquid Effluents (Radiological and Chemical Hazard Constituents)

Baseline Mode:

- Steam (Industrial Hazard)
- Reagent Gases (e.g., Argon, Nitrogen) (Chemical Hazard)
- Electrical (Industrial Hazard)
- Pressurized liquids (Industrial Hazard)

DFHLW Mode (Anticipated. Note: all of the hazard types associated with DFLAW also apply to DFHLW even if the quantities / risks may differ):

- Radiological Hazards originating from the proposed vault (see Risks & Opportunity in Section 9)
- Steam plant hazards
- Previously unconsidered gases unique to DFHLW operation

There is no explosive material stored or used in activities in the Lab Facility. Due to the use of certain chemicals (e.g., concentrated nitric acid), there is the potential for an energetic interaction to take place. Any interaction of this type would be small and be limited by the amount of chemicals involved therefore the hazards are not considered at the facility level. The potential for these chemical interactions is limited by invoking the provisions of 10 CFR 851 and 29 CFR 1910.

DFLAW does not directly interface with the HLW Facility, with both utilizing an intermediary Lab Facility (no direct interface), therefore no cross-facility related hazards are anticipated. Diluted HLW samples will be analyzed in the Lab Facility ARL system alongside DFLAW samples. This is the only instance wherein DFHLW and DFLAW originated hazards are co-located.

3 Process Assumptions

This section establishes the approach to utilizing and maintaining current safety design basis documentation and addresses the graded application of the safety design basis. Process assumptions will be utilized in developing a Safety Design Strategy (SDS) that will be used for transitioning safety design basis documentation to a safety basis (Documented Safety Analysis (DSA) and Technical Safety Requirements (TSR)), including details on the conventional approach.

The assumptions governing plans to permit limited construction to proceed will be explicitly included and justified. For areas with existing program frameworks, such as the HLW Quality Assurance Program, summary-level descriptions are included with a reference to more detailed program descriptions where applicable. If the program approach and documentation require revision, this information is also provided.

3.1 Safety Design Strategy

The HLW Vitrification Project, including interfacing project level facilities such as Lab when in support of DFHLW operations, integrates safety-in-design by following the guidance in DOE-STD-1189-2016, including safety design guiding principles and hierarchy of controls (e.g., controls closest to the hazard are considered to provide protection to the largest population of potential receptors, including FWs, co-located worker, and the public). The aspects of the safety design strategy are discussed in the following sections.

3.1.1 Safety Design Criteria

Safety design criteria for the HLW Project will include the safety design criteria requirements described in DOE O 420.1C, Change 3, *Facility Safety*. Exemption 9 of DOE O 420.1C, Change 3 is invoked for DOE-STD-1020-94, see Section 6.1.2 for more details. In addition, the following contain specific criteria or guidance for implementing those requirements:

- DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C Facility Safety*
- DOE-STD-1066-1997, DOE Standard – *Fire Protection**
- DOE-STD-1020-1994, Change Notice 1 (1996), DOE Standard – *Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities* (Lab Facility and HLW Facility)
- DOE-STD-1020-2016, DOE Standard – *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities* (HLW Support Facilities)
- DOE-STD-1189-2016, *Integration of Safety into the Design Process*
- DOE-STD-3009-2014, DOE Standard – *Preparation of Nonreactor Nuclear Facility Documented Safety Analyses* (HLW Facility)
- DOE-STD-1228-2019, DOE Standard – *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities* (Lab Facility)

* *DOE-STD-1066-1997* will be implemented as modified in the Fire Protection Implementation Plan

Design criteria for the Lab Facility will be defined and implemented, along with hazard recategorization, to preclude any interruption to ongoing DFLAW operations.

Specific design codes and standards to be used for the design of the safety SSCs are identified in the 24590-WTP-COR-MGT-18-00001, *Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities,* which will be updated accordingly.

Nuclear safety analysis documents analyze potential accidents and their associated consequences, which determines the adequacy of the measures taken to eliminate, prevent, or mitigate identified hazardous releases. Consequence calculations quantitatively evaluate the potential radioactive and hazardous material consequences to the public receptor (also called the maximally exposed offsite individual, or MOI) and co-located worker (CLW) for each analyzed accident scenario. For these receptors, the consequences to an individual are assessed at the limiting location for that population. The aforementioned analyses are generated in accordance with the 24590- HLW-3DG-W10W-00001, *HLW Nuclear Safety Analysis Design Guide,* which describes the general methodology for performing consequence calculations and ensuring the methods align with applicable DOE standards. This design guide is applied to both the HLW and Lab facilities.

By nature, the collective elements in the safety analysis process introduces safety criteria early in design via the conservative inputs and methodologies used in analyses. At present, two specific methodologies have been developed for spray leak and liquid spill scenarios to be used in the safety analyses:

- 24590-WTP-RPT-ENS-10-001, *WTP Methodology for Spray Leak Scenarios*
- 24590-WTP-RPT-ENS-13-020, *WTP Methodology for Liquid Spill Scenarios*

Some of the other criteria used in the safety analysis process include:

- **Radiation Hazard Distances (CLW Receptor & Public Boundary)**

  DOE-STD-3009-2014 establishes the basis for the receptor location for the evaluation of radiological hazards for a CLW at a distance of 100 meters from the facility or estimated release point. The CLW receptor location is distinct from the site boundary. The public receptor location is based on the site boundary distances as analyzed in 24590-WTP-Z0C-W14T-00028, *Minimum Distances to the Public Boundary* and varies from 22,200 meters (13.8 miles) to 9,700 meters (6.0 miles) from the release point.

- **Atmospheric Dispersion Factors**

  For events concerning radiological and hazardous chemical releases, the HLW Facility analysis will select an alternative CLW χ/Q that is more applicable to the HLW Facility and/or WTP site characteristics following the DOE-approved modeling protocol for the HLW Facility (CCN 336729 (23-NSD-0042); 24590-HLW-RPT-NS-23-001, Atmospheric Dispersion Modeling Using ARCON96 for Co-located Worker (CLW)). This protocol provides the justification and technical basis for an alternate χ/Q for the CLW as required by DOE-STD-3009-2014, Section 3.2.4.2.

  Potential use of an alternate on-site (CLW) χ/Q for the Lab Facility is pending further evaluation.

  Public receptor χ/Qs for use in safety analyses are determined using meteorological data from Hanford Meteorological Station (MHS) and the DOE-approved toolbox code MACCS2. Although this method has been previously approved, in fulfillment of "Option 3" in DOE-STD-3009-2014, Section 3.2.4.2, a modeling protocol will be formally developed and provided to DOE for approval.

- **MAR**

  The MAR is the total maximum quantity (i.e., volume, mass, activity, etc.) of material (e.g., radioactive) at a location that may be impacted by the event.

- **Airborne Release Fraction (ARF), Airborne Release Rate (ARR) & Respirable Fraction (RF)**

  The bounding values of Airborne Release Fraction (ARF) or Airborne Release Rate (ARR), and Respirable Fraction (RF) (typically found in DOE-HDBK-3010-94 or NUREG/CR-6410) are applied to calculate source terms for consequence analysis unless bounding but still conservative values from DOE-HDBK-3010-94 are justified as appropriate to the scenario. Industry validated empirical data available from operating experience at other facilities or from experiments reported in the literature may be used.

- **Damage Ration (DR) and Leak Path Factor (LPF)**

  The Damage Ration (DR) and Leak Path Factor (LPF) are both assumed to be equal to unity in the analysis, conservatively assuming no reduction.

- **Breathing Rate (BR)**

  A breathing rate for a sedentary worker (1/3 sitting and 2/3 light activity) of 3.33E-04 m3/s will be used for both the CLW and members of the public.

- **Unit Dose (UD) Factors and Dose Conversion factors (DCF)**

  UD factors for affected receptors for the recent direct feed HLW waste acceptance criteria specifying maximum radionuclide activity for the HLW Facility (24590-HLW-ES-TD-24-001, Rev 0, *DFHLW Configuration Optimized WAC Formal Engineering Study*). The DCFs to be used for HLW Facility safety analysis calculations will be cited from International Commission on Radiological Protection (ICRP) Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*, and ICRP Publication 72, *Age-dependent Doses to Members of the Public from Intake of Radionuclides*.

3.1.2 Safety Design Functional Requirements

SSCs are functionally classified based on hazard and accident analysis unmitigated consequences. For analyzed hazard and accident scenarios that have high or moderate consequences to the public or CLW and whose unmitigated scenarios fall into risk group rankings of I and II (specifically those high-frequency unmitigated scenarios that fall into risk group rankings of I and II versus low frequency / high to moderate consequence scenarios that fall into risk group ranking III and IV), it is necessary to identify controls in the HA process and consider whether they are to be elevated to safety (either safety class or safety significant).

An unmitigated consequence of High to a public receptor due to radiological consequences necessitates the identified control for risk reduction to be classified as SC, identified as either SSCs or SACs. SS designation of a control, or identification of SACs is for all other CLW and public receptor unmitigated event risk rankings I and II, whether radiologically or chemically based. For high FW consequences (i.e., scenarios that may result in prompt worker fatality or serious injuries or significant radiological or chemical exposures, or an injury requiring medical treatment for immediately life-threatening or permanently disabling injury that would initiate or worsen a radiological event or compromise the ability of facility operators to respond to nuclear events), identified control(s) are required to be designated as SS or identified as SACs per DOE-STD-3009-2014. Additional controls may be identified as safety SSCs or SACs, based on being major contributors to DiD.

The HLW Project utilizes a safety and hazard control strategy consistent with DOE-STD-1189-2016 and follows the hierarchy of control selection as follows:

"After hazardous material minimization/elimination and application of inherently safer design concepts where practical, a control strategy shall be (a) selected to prevent or mitigate releases of hazardous materials and to provide defense in depth, and (b) based on the following order of preference:

- *SSCs are preferred over administrative controls.*
- *Passive SSCs are preferred over active SSCs.*
- *Preventative controls are preferred over mitigative controls.*
- *Controls closest to the hazard may provide protection to the largest population of potential receptors, including workers and the public.*
- *Controls that are effective for multiple hazards can be resource-effective."*

The results of the preliminary functional requirements of SSCs are included in Appendix M of 24590-HLW-PDSA-NS-24-0001, *Preliminary Documented Safety Analysis for the High-Level Waste Facility*. These functional criteria will be revised and updated in the PDSA based on the methodology and criteria described in DOE-STD-3009-2014 and any impacts due to the DFHLW approach. The functional requirements will be updated as design progresses with the final preliminary functional requirements included in the final PDSA.

Interfaces between the HLW Facility and the Lab Facility when in DFHLW mode will be addressed within the revised Lab PDSA based on the methodology and criteria described in DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities.* The same safety and hazard control strategy consistent with DOE-STD-1189-2016 will be utilized for the Lab Facility as described for the HLW facility however the development of the PDSA utilized by the HLW Facility will be in accordance with DOE-STD-3009-2014 while the Lab Facility will utilize DOE-STD-1228-2019.

3.1.3 Safety Design Integration Process

Changes to the design, hazards, and resulting safety controls are reviewed and if appropriate discussed in Safety Design Integration Team (SDIT) meetings and communicated to the Contractor Integrated Project Team (CIPT), as required by DOE-STD-1189-2016. The SDIT consists of a core technical team and additional subject matter experts (SMEs) who may be called upon to accomplish specific tasks. The core SDIT team will represent the primary functional areas relied on to identify and control hazards, which will consist of personnel such as nuclear safety engineering, engineering, design authority, and operations and maintenance (see Section 11). One of the core functions of the SDIT is to ensure that assumptions made in this SDS are protected, including proposing and implementing organizational processes to ensure safety controls are protected.

Once the agreement is reached, the change is proposed in a HLW Facility PDSA change format and submitted to HFO for approval, and if approved, the change will be captured in the HLW Facility PDSA (24590-HLW-PDSA-NS-24-0001). Similarly for the Lab Facility, changes proposed, reviewed, and approved by HFO will be captured in the Lab Facility PDSA (24590-WTP-PSAR-ESH-01-002-06).

The change management for the WTP Project is maintained under the safety evaluation (SE) process (see Section 10.6). Additionally, processes for verifying requirements have been incorporated into the design include system design reviews and the completion of requirement verification matrices. These processes are intended to be a verification that the safety-in-design integration process of the SDIT team was properly implemented. Changes to interfacing facilities (e.g. Lab Facility, BOF, or DFHLW alternate configuration facility boundary) will be captured in the facility specific PDSA and/or Hazard Analysis Reports.

3.1.4 Interface with Existing Analytical Lab Safety Basis

The Analytical Lab is currently operated as a less than HC-3 facility with an implemented HAR, however, the original design scope of the Lab was to be operated as a HC-3 nuclear facility. Based on this original scope a draft PDSA for the Lab facility exists. Though this PDSA is aged and not currently written in alignment with DOE-STD-1189-2016 the technical information contained within and the associated hazards analysis are complete and thorough. Prior to this major modification the Lab PDSA will be updated to align with DOE-STD-1189-2016 and DOE-STD-3009-2014. This SDS and the associated PDSA will define the safety basis for the implementation of the full design into the existing facility. Since the PDSA will be written for the entire facility all appropriate safety controls or features will be configuration managed.

Transition of the operations from the HAR safety basis to the PDSA/DSA safety basis will be determined based on potential impact to operations and mission needs. Additional detail regarding this transition will be added in future SDS revisions.

3.1.5 Design Process Maturity

As the project progresses, designs will be refined to incorporate vendor information, to integrate with interfacing systems, and to address planned design and operational safety improvements (PDOSI). Early procurement of long lead items will allow complex safety SSCs (e.g., gas analyzers, thermal catalytic oxidizers, etc.) to be delivered in time to verify the equipment meets requirements and provide information on any changes to engineering and nuclear safety. Preliminary TSRs will be developed as early as possible to inform both design and operational requirements and will be documented as part of Chapter 5 of the respective HLW Facility and Lab Facility PDSAs.

Engineering will be performed to provide on demand calculations aligned with the safety basis requirements for process analytical limits, allowable values, and nominal trip set points for instrumentation, along with SSC failure probabilities. The PDSAs will be maintained in alignment with design via the safety evaluation process and regular PDSAs change packages or revisions and the preliminary TSRs. Supporting safety analysis calculations and hazard analysis will be updated as necessary.

As the project transitions from preliminary to final design, each of the systems will begin to mature to 90% design complete. To be considered 90% design complete, each system must have final drawings and specifications, and a set of clearly defined testing requirements and acceptance criteria. Additionally, System Design Descriptions (SDDs) and Facility Design Descriptions (FDDs) must be updated to incorporate the safety design basis requirements. Requirement Verification Matrices have been developed and/or updated to provide the actual verification of requirements from the SDDs/FDDs. When these prerequisites are complete, each system will undergo a system design review to confirm they have reached or exceeded the 90% design threshold. Any PDOSI that potentially affects the design should be closed by the 90% design threshold. PDOSI that do not impact the design may still remain and be tracked at this point.

As the Analytical Laboratory is at present design complete and operational in support of DFLAW the facility is considered as exceeding the 90% design threshold. However, in those portions of the facility required to support DFHLW (e.g. hotcells and associated ventilation/containment systems) the same process used in the DFHLW in the management of pre-90% threshold design maturity will be used to update and maintain the design. This includes relevant drawings, specifications, testing requirements and acceptance criteria. SDDs and FDD will be updated and maintained to the same standard.

3.1.6 Design Upgrade Analysis

The planned modifications to the HLW facility is being considered a new nuclear facility and no design upgrade analysis is needed or performed.

The scope of the major modification for the Analytical Laboratory (addition of DFHLW samples and use of the hot cell areas) has been considered in the design since inception. There are limited areas of contact between the operational labs and the hot cell lab. These areas of contact are limited to utility supply systems (air, water) and offgas. To mitigate future impacts, the original commissioning of the Lab offgas considered and simulated operation of the hot cells. It is likely that the system will require re-balancing, but this early simulation provides assurance that impacts to the offgas will be limited. The COR used for the Lab Facility will be reviewed against the codes and standards implemented by this SDS and the COR for the DFHLW project. Any specific application of the design upgrade analysis related to codes and standards will be implemented during finalization of the design and documented in future revisions of this SDS.

3.1.7 Incorporation of DFLAW Lessons Learned

Major lessons learned themes from the DFLAW project will be implemented in the HLW Facility design as part of 24590-HLW-PL-MGT-22-001 *HFFT Lessons Learned Implementation Plan*. Whenever pertinent, DFLAW lessons learned will be implemented in the design and/or modifications of Lab Facility SSCs required to support DFHLW operations. A database of lessons learned has so far been compiled and categorized for applicability to the HLW Facility EPC, commissioning, operation, and maintenance plans. These lessons learned will be further categorized and then implemented through several change management plans to achieve early communication and implementation into the design as appropriate. Further, lessons learned will be evaluated during any design reviews performed by system to preclude repeat issues. Some of the topical areas for lessons learned are listed below (this list is not comprehensive as the database and areas of learning will continue to grow as DFLAW commissioning and operation progress):

- Construction
- Project Management
- Startup / Commissioning
- Engineering / Design
- Testing
- Operability
- Aging & Obsolescence Strategy
- Maintenance

3.2 Safety Basis

3.2.1 Analysis Types

The development of the safety design basis documents will follow the safe harbor methodologies set forth in DOE-STD-3009-2014 and DOE-STD-1228-2019 that establish an adequate safety design basis for managing the risk from the analyzed HLW Facility and Lab Facility operations, respectively. Appropriate, technically justified evidence will be provided to support the conclusion and documentation of the HLW Facility and Lab Facility PDSAs.

One of the steps in safety basis documentation includes the preparation of the hazard analysis, which is the method used to identify materials, systems, processes, and plant characteristics that can produce undesirable consequences, and to assess the hazardous situations associated with facility processes and operations.

The HA includes hazard identification, hazard categorization, hazard evaluation (e.g., what-if analysis, process hazard analysis, etc.). The HA is supported by the graded application of accident analysis techniques including development of the design basis accidents (DBAs) and evaluation basis accidents (EBAs), designation of safety significant (SS) and safety class (SC) controls, and presentation of the results of the mitigated analyses. Implementation of the mentioned processes will ensure the adequacy and compliance of the HLW Project PDSA to BNI regulatory and contractual commitments. Use of the formal Accident Analysis process is only applied whenever it is required by the standard and implemented using the same process as existing HA. In lieu of this process, the formal application of AA techniques will be applied to the HA in a graded fashion, as appropriate, and as described in DOE-STD-1027-92, Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23,* *Nuclear Safety Analysis Reports*. The same approach, whenever applicable, will be applied to the Lab Facility hazard analysis. The hazard analysis process is depicted in Figure 6:

Figure 6 Hazard Analysis Process

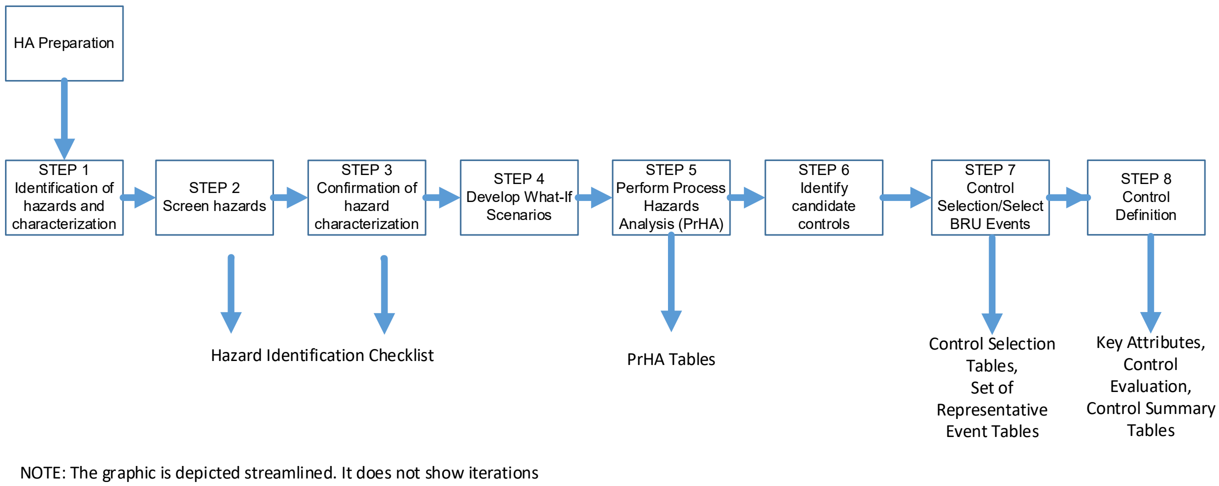
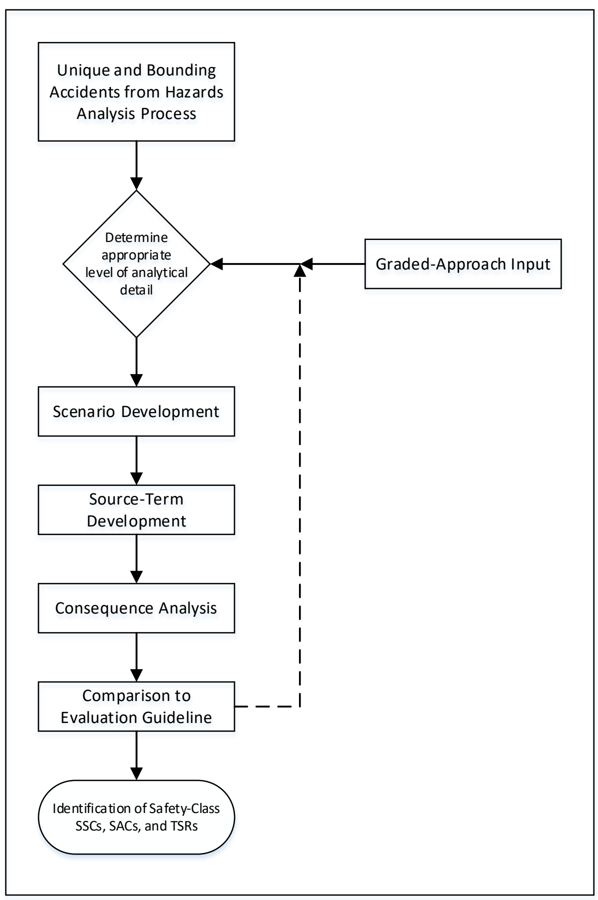


Figure 7 Safety Analysis/Accident Analysis Process Overview



Safety analysis calculations will be updated/developed to support the hazards analysis and accident analysis processes. For example, for the HLW Facility the analyses include:

- Site boundary distances determination
- Meteorological data preparation
- Atmospheric dispersion factors determination
- Unit dose and waste stream parameters evaluation
- Radiological and hazardous chemical consequence analysis, etc.

Similar determinations and analyses will be updated/developed for the Analytical Laboratory to support DFHLW operations.

Types of events that are evaluated in the HLW and Lab Facility HA include:

- Fire
- Explosion
- Loss of confinement
- Direct exposure
- Criticality
- External events
- NPH events

Examples of DBAs/EBAs analyzed include:

- Liquid spills, molten glass spills, overflows
- Spray leaks, pressurized releases and overblows
- Glass canister drops, secondary radioactive solid waste events
- Hydrogen explosions
- Melter offgas releases
- Fires
- Ammonia releases
- External events including natural phenomena (e.g., seismic, wind, flood, snow, ash, lightning, and wildland fire)
- Man-made External events (aircraft crash, transportation accident, or adjacent facility events)

3.2.2 Project Lifecycle Documentation

The HLW Facility has partially completed some construction activities predominantly associated with the physical structure of the facility. However, due to the nature of the construction and scope of the project, the SSCs and support systems are in different phases of design completion. The majority of systems are greater than 60% design complete. It should be noted, however, that some systems are in an earlier design phase due to the necessity to modify design as a result of the DFHLW approach.

The Lab Facility is already operational as a less than HC-3 facility. The portions of the Lab Facility that would support DFHLW are anticipated to require operation as a HC-3 facility designation, thus those systems requiring modification / augmentation will require revision to the Lab Facility PDSA and COR documents.

The goal of the final design phase is to reach 90% design completion capable of supporting procurement, construction, testing, and operation. Throughout the design progression and as part of the final design phase, the SDS, fire hazards analysis (FHA), PDSA (including PrHAs and Preliminary TSRs), security vulnerability assessment (as applicable), R&OA (or equivalent), and COR documents will be developed or updated. During the construction and transition to operations phase, the DSA and TSRs (derived from the DSA) will be developed based on the approved final design and any changes made during construction. Upon design completion and the end of the construction and transition to operations phase, the DSA and TSR document will be finalized and reviewed and approved by DOE (retiring PDSA and SDS post-commissioning). The HLW and Lab Facility DSAs will be consistent with the as-built configurations of the respective facilities.

3.2.3 Approach to Safety

Adoption of DOE-STD-1189-2016 will be implemented with an approach reflecting the current phase of the project. Previously, the HLW Facility followed DOE-STD-3009-94 to inform the safety design basis development effort, with supplemental direction from 15-NSD-0017 (CCN 281177) that was intended to bring the requirements and criteria closer to the requirements of DOE-STD-3009-2014 and DOE-STD-1189-2016. The requirements and criteria for Lab will follow the requirements of DOE-STD-1228-2019.

A multi-discipline effort conducted by members of BNI and DOE Hanford Field Office (HFO) (formerly Office of River Protection (ORP))was performed to drive alignment, agreement, and decision on key topics, plans, and needs for completing the HLW Facility project considering the implementation of discussed standards and the DFHLW Project scope. Detailed discussion of impacts and recommendations are documented in Section 4.4 of 24590-HLW-ES-ENG-22-004-08, *Code of Record Evaluation – HLW Firm the Foundation Volume 8 – Nuclear Safety Engineering.*

It should be noted that implementation of DOE-STD-1189-2016 and DOE-STD-3009-2014 (for the HLW Facility) and DOE-STD-1228-2019 (for the Lab Facility) will be considered complete when existing safety design basis documents have been revised to be compliant with the implemented requirements. This includes PrHA events and controls.

3.3 Safety Documents

The DFHLW Project has several key project safety documents that provide safety information and analysis for the construction of the facility including:

- Safety Design Strategy (SDS)
- Preliminary Documented Safety Analysis (PDSA)
- Process Hazards Analysis (PrHA)
- Preliminary Fire Hazard Analysis (PFHA)
- Criticality Safety Evaluation Report (CSER)
- Basis of Design (BOD) Documents (*)

The above safety design basis documents will be revised as needed to align with HLW Facility design, operational, and process changes (as discussed in Section 5), and the implementation of updated codes and standards for the HLW Facility (as discussed in the Tailoring discussion of Section 6.3), and in particular to meet the requirements of DOE-STD-3009-2014. For those safety design basis document types in the list above that apply to Lab, the requirements of DOE-STD-1228-2019 will be met. The project documents listed above will be refined with additional detail via revisions as the project moves towards completion. (*) The BOD documents are not safety / safety basis documents however they are upper tier engineering design criteria documents. The safety design basis includes the BOD as provided in the COR, with the BOD as a source of criteria used in the tailoring of certain codes.

To support DFHLW operations, it is anticipated that Lab will require a commensurate level of key project safety documents as an HC-3 facility in the above lists. These documents are anticipated to supersede the existing Hazards Analysis Report governing the existing activities (DFLAW support) by the Lab Facility.

3.4 Quality Assurance (QA)

3.4.1 QA Program

The quality assurance program provides for conduct of work that ensures the protection of workers, the public, and the environment, considering the work to be performed and the associated hazards. The program requires that work be planned, documented, performed under controlled conditions, and periodically assessed to establish work item quality and process effectiveness, and to promote improvement.

WTP's quality assurance program (QAP) consists of the HLW and DFLAW QAPs. The DFLAW QAP is implemented through two unique quality assurance components – engineering, procurement, construction, and startup (referred to as the EPC component); and commissioning, maintenance, and operations (referred to as the C&O component).

The DFLAW EPC QAP, which applies to the DFLAW Project, consists of 24590-WTP-PD-RAQA-QA-0001, *Quality Assurance Program Description*, 24590-WTP-QAM-QA-06-001, *DFLAW Engineering, Procurement, and Construction Quality Assurance Manual*, 24590-WTP-QIP-RAQA-QA-0002, *DFLAW Engineering, Procurement, and Construction Quality Assurance Implementation Plan*, and 24590-WTP-PD-RAQA-QA-0002, *DFLAW Graded Approach*. The flowdown of current EPC quality program requirements includes 10 CFR 830, DOE O 414.1D, DOE/RW-0333P Quality Assurance Requirements and Description (QARD) Rev 20, and NQA-1-2000 (with some tailored requirements from NQA-1-2004 and NQA-1-2008/2009). The applicability of requirements from the QARD is limited to those items and activities that are designated as immobilized high-level waste acceptance impacting.

The DFHLW QAP, which applies to the DFHLW Project, consists of 24590-HLW-QAM-RAQA-QA-0001, *HLW Quality Assurance Manual* and 24590-HLW-PD-RAQA-QA-0001, *HLW Graded Approach*. The flowdown of current HLW quality program requirements includes 10 CFR 830, DOE O 414.1D Chg 2, DOE/RW-0333P Quality Assurance Requirements and Description (QARD) Rev 20, and NQA-1-2022 (with tailored requirements from NQA-1-2022, Subparts II & III). The applicability of requirements from the QARD is limited to those items and activities that are designated as immobilized high-level waste acceptance impacting.

3.4.2 Implementation Strategy

The strategy for QA implementation for the DFHLW Project going forward is the implementation of 24590-HLW-QAM-RAQA-QA-0001, *HLW Quality Assurance Manual.* This project specific QAP based on the requirements from 10 CFR 830, DOE O 414.1D Chg 2, QARD, and NQA-1-2022 (edition pending DOE approval). The transition from the current EPC QAP requirements to the DFHLW Project specific QAP will include the following implementation activities:

- Determine changes necessary for applicable programs, plans, and procedures primarily driven by the transition to DOE O 414.1D Chg 2 and NQA-1-2022 (edition pending DOE approval) and the addition of applicable NQA-1 Part II requirements for the DFHLW Project. – Completed
- Implement the changes identified and train the applicable project staff on the changed requirements.

- Periodically assess the status of and compliance with implementation of the DFHLW Project QA program. This will include team status meetings as well as results from DFHLW Project QA audits, assessments, and surveillances (including at supplier facilities).

As with the current EPC QAP, applicability of QARD requirements in the HLW QAP is limited to those items and activities that are designated as immobilized high-level waste acceptance impacting.

3.5 Authorization for Procurement Strategy

The procurement strategy for the HLW and Lab Facilities moving forward is for the design to have reached 90% complete prior to most procurement activities in alignment with DOE-STD-1189-2016. The intent of the DFHLW Project is to pick up the design after completion of CD-4B. Prior to awarding procurement of equipment, an engineering evaluation of the risks associated with procuring the equipment (that could result in re-ordering or modifying the equipment) is completed. This engineering evaluation may be documented as a standalone document or as part of a system design review package. Engineering and procurement may decide to go out for bids ahead of completion of the engineering evaluation but will not award procurement of the equipment until the engineering evaluation is complete. Areas of review for this evaluation include but are not limited to the following items for potential changes in the future:

- Review of the code of record to the most current editions/revisions of the applicable codes and standards
- Verify design in alignment with the PDSA
- Review of waste acceptance impacting (WAI) functions
- Review of any permit affecting documents to verify that they are current
- Review for potential equipment obsolescence/aging issues
- Review of Lessons Learned to ensure those that are applicable are implemented
- Verify effect of potential future DFHLW approach incorporation into the current design
- Verify whether critical characteristics of the equipment change due to any identified engineering impact evaluation (EIE) to interfacing systems as well as the equipment itself

This information is compiled and presented to senior management for a decision as to whether to move forward with the procurement with either no action items or action items that need to be closed before awarding the procurement of the equipment. In addition, the management team may choose to have the engineering team address all or some of the action items and resubmit the evaluation to senior management before deciding to award the procurement based on the high risk of change in those action items.

The Analytical Laboratory is an operating facility operating in support of DFLAW. The Lab Facility will be modified as necessary to support DFHLW. Procurements related to these modifications will undergo the same review, evaluation, and approval process as delineated above for the procurements associated with the HLW Facility.

3.6 Configuration Management (CM)

3.6.1 CM Plan

Configuration Management (CM) is a process for establishing and maintaining consistency among facility documentation, design documentation, and physical configuration of Structures, Systems, and Components (SSCs) throughout the life of the facility. The DFHLW Project CM Program Description (CM PD) will define how the project will satisfy CM technical and operational requirements applicable to the DFHLW

Project contract with specific requirements identified and flowed down via an HLW CM Requirements Document (CM RD).

The DFHLW Project CM program will be based on DOE-STD-1073-2016 and ANSI/EIA-649B (primarily 1073) and incorporates DOE-STD-1189-2016. During the process of defining the DFHLW Project CM program, lessons learned from DFLAW were considered and the CM programs for the Hanford Site Tank Operations Contract and Central Plateau Cleanup Contract were reviewed. The five CM elements from 1073 that identify how the HLW Project CM PD will be structured are:

- Design Control
- Work Control
- Change Control
- Document Control
- Assessments

CM implementation requires a balanced and consistent application of the CM elements. Maximum benefit from the CM processes is assured when the five CM elements work together throughout the project life cycle. The degree to which CM requirements apply to a facility or SSC varies over the project life cycle. For example, while aspects of future facility operations and post-operation activities (i.e., Deactivation & Decommissioning) are considered during the EPCC phase of the project, facility operations and D&D are out of scope for the current DFHLW Project contract. Turnover of CM related information (e.g., as-built documentation) to the future HLW Facility operations contractor will be addressed in a contract transition plan.

The extent and degree of rigor necessary for CM implementation is commensurate with the type of facility and SSC. A complex facility or SSC typically warrants a more robust CM approach. A simpler CM approach may be applied to noncomplex facilities and SSCs while still maintaining the needed consistency between essential requirements, configuration information, and the installed SSC. The CM PD will describe how a graded approach is applied for the DFHLW Project facilities, including HLW SSCs that are considered CM SSCs. In accordance with 1073, the minimum CM SSCs will include the Safety SSCs (i.e., SC and SS SSCs) identified in the HLW Facility safety basis.

3.6.2 Implementation Strategy

The DFHLW Project CM PD will describe roles and responsibilities, the five program elements, define interfaces, and how the graded approach is applied to the CM processes. A major focus area will be describing the processes by which the design basis and safety basis maintain alignment (e.g., definition of CM SSCs, design change process, procurement requirements for SC/SS SSCs, As-Built documentation, etc.). Although the CM PD for DFLAW is separate from the As-Built PD, the plan for the HLW Project is to have a single CM PD which includes appropriate As-Built information. Although the CM PD for DFLAW does not require formal DOE approval, the plan for the DFHLW Project is that the CM PD will be a document which requires formal approval by DOE (in part because the graded approach for CM will be explained in the CM PD).

The new DFHLW Project CM program will integrate safety and design activities while implementing system walkdowns and firming up the as-built process. Specific actions to be taken to document as-built design will be defined in the DFHLW Project CM Program Plan when developed. The DFHLW Project CM program will be tailored to address the current status of the HLW Facility design and safety bases. Changes that have the potential to impact safety in design will be controlled to ensure the proposed HLW Facility scope and design remain in a configuration that is bounded by the configuration analyzed in the PDSA.

A tool will be implemented to track design implementation of current and future PDSA requirements to ensure requirements of SSCs are implemented in design documentation and are consistent with the PDSA. This will reduce the risk of misalignment of the PDSA, design, and as-built configuration of the facilities and minimize the risk of rework. The integrity of the PDSA configuration baseline is protected by a PDSA change control process. This process is based on guidelines and criteria specified in Section 3.8.3 of DOE-STD-1189-2016.

Once the CM PD is approved, CM requirements will be flowed down to each applicable Requirement Area (RA) via a CM Requirements Document. Each RA manager ensures CM requirements are incorporated into procedures and processes. Personnel are subsequently trained and qualified to these procedures and processes that implement CM requirements. Following procedures and processes ensures configuration control of project design documents. Periodic performance assessments are performed to ensure compliance with CM requirements.

3.7 Discipline Specific Requirements & Commitments

The following requirements and commitments apply only to the HLW Facility and Analytical Laboratory when supporting DFHLW operations.

3.7.1 HLW Facility Design Life

The HLW Facility is designed for a 40 year nominal service (operating) life in accordance with current contract requirements. The permanently installed equipment is designed for 40 years of operation, considering the high-radiation environment; the corrosive, erosive nature of the process streams; and the projected normal, off-normal, or accident environmental conditions, as appropriate. Replaceable equipment is designed for its intended design life, considering the high-radiation environment; the corrosive, erosive nature of the process streams; and the projected normal, off-normal, or accident environmental conditions, as appropriate.

In developing the Safety Basis, the configuration of the facility and systems (SSCs) are evaluated as documented via approved design drawings/specifications/test data/etc. and are expected to perform as designed. Permanent materials are evaluated for continuous exposure over 40 years to the worst-case conditions expected during normal operation, which may include the radiation level of the environment, flow rates, solids loading, stream pH, heat stresses, etc. Short-term transients that result in off-normal conditions are included in analyses where appropriate.

Certain SSCs have a combination of a system level 40 year design life and sub components service windows significantly less, which will require periodic replacement and/or removal/maintenance (in service inspections).

Some equipment specific items relative to design life are as follows:

- Melters are designed to operate for a 5 year service window with periodic removal/replacement. A dedicated HLW melter handling system (HMH) to handle the melters will be employed in order to handle the size, weight, and contamination levels
- PVV and HOP primary offgas components that are fully welded are designed for the full service life and require no hands on maintenance while those that require maintenance have been installed in cells or caves that allow for remote maintenance
- Some components (like air amplifiers, demisters, and demister packings) are designed to be remotely removable and replaceable during the 40 year facility operating window

- Shielded Personal Access Doors are designed to function for the full 40 year window with the exception of door seals and hinge bearings which are easily replaceable for maintenance or recovery
- Some pumps, instruments, valves, or specialized fittings may require maintenance during the operating life. These components will be managed via piping loop bulges

The Analytical Laboratory will be designed, operated, and maintained to support the full WTP project waste processing mission, goals, and objectives including but not limited to operating during the operational life of the HLW Facility.

3.7.2 Civil / Structural

The Civil Structural impacts of the new direction for completion and operation of the HLW Facility are primarily reserved to the evaluation of new codes and standards and the impact on already constructed and designed equipment. Overall, the facility design is reviewed against the latest versions of codes and standards and original standards are retained when they bound the new requirements. This is due to the state of construction of the HLW Facility, and the lack of value provided by reworking the design to a lesser criterion.

New base ground motion input curves were generated in 2014 as part of the Hanford Site Probabilistic Seismic Analysis. Comparisons of preexisting RGM and WSGM base ground motion input curves to the new curves demonstrate that the existing seismic design, which is the controlling load case for the building and other environmental loads, conservatively envelop newer design categories from the 2016 version of DOE-STD-1020. The recommendation is to retain DOE-STD-1020-1994 (Change 1, 1996) in the HLW Facility COR for the existing design of HLW SSCs. In addition, for new facilities being considered adjacent to or supporting the main HLW Facility, the recommendation is to implement the current version of DOE-STD-1020-2016 for civil design.

3.7.3 Mechanical

The DOE DFHLW treatment alternative solution, with subsequent updated contractual direction, will result in changes to the mechanical systems within the existing HLW Facility. Mechanical systems will be evaluated and redesigned to accommodate the changes (e.g., feed stream variation) as needed. Impacts include but are not limited to, modification to the waste treatment processes within the facility to address new variations in the waste feed and addressing the effluent processing within the facility or sending effluent out of the facility to be managed. Integration with BOF utilities and development of dedicated HLW Facility utilities will need to be evaluated. Integration with the Lab Facility will also need to be evaluated when in support of DFHLW. The extent of changes may result in physical change to constructed, procured, and installed equipment along with potentially impacting ongoing procurements.

Lessons learned from DFLAW may result in design changes within the HLW Facility of varying significance. An anticipated significant impact involves modification of the GFR system to efficiently feed glass formers to the melter feed preparation vessels.

3.7.4 Electrical

Procurements of electrical SSCs have already, in general, been performed to the most modern codes and standards due to legal requirements of companies providing electrical components. The electrical systems are anticipated to be simplified by a move to SS controls rather than SC controls. This would simplify the requirements for redundant cabling in many cases. Even in this transition, some of the cables will remain redundant (C5V system and HFP agitators). The PPJ system may also have redundancy.

The primary power feed at the A6 substation is anticipated to require modification for a capacity increase and/or additional power to be provided at the Hanford site by DOE. These modifications include the addition of a new Balance of Facilities (BOF) switchgear building. The BOF Switchgear Building, Building 34, is primarily designed to provide medium voltage (and limited low voltage) electrical power to the new electric Steam Plant (B39) (still in design), the HLW Facility, new BOF buildings such as Wet Chem Building (B38) and Emergency Power Building (B37), and future proposed vault for DFHLW. This switchgear building will contain sufficient excess capacity margin to accommodate future load growth. Emergency Backup power systems are in early design and changes in requirements may result in a change in technology selection (turbine vs. diesel) as well as the need for uninterruptible power supplies to manage loads during transfer of the facility into its safe state (primarily post seismic).

3.7.5 Chemical Safety

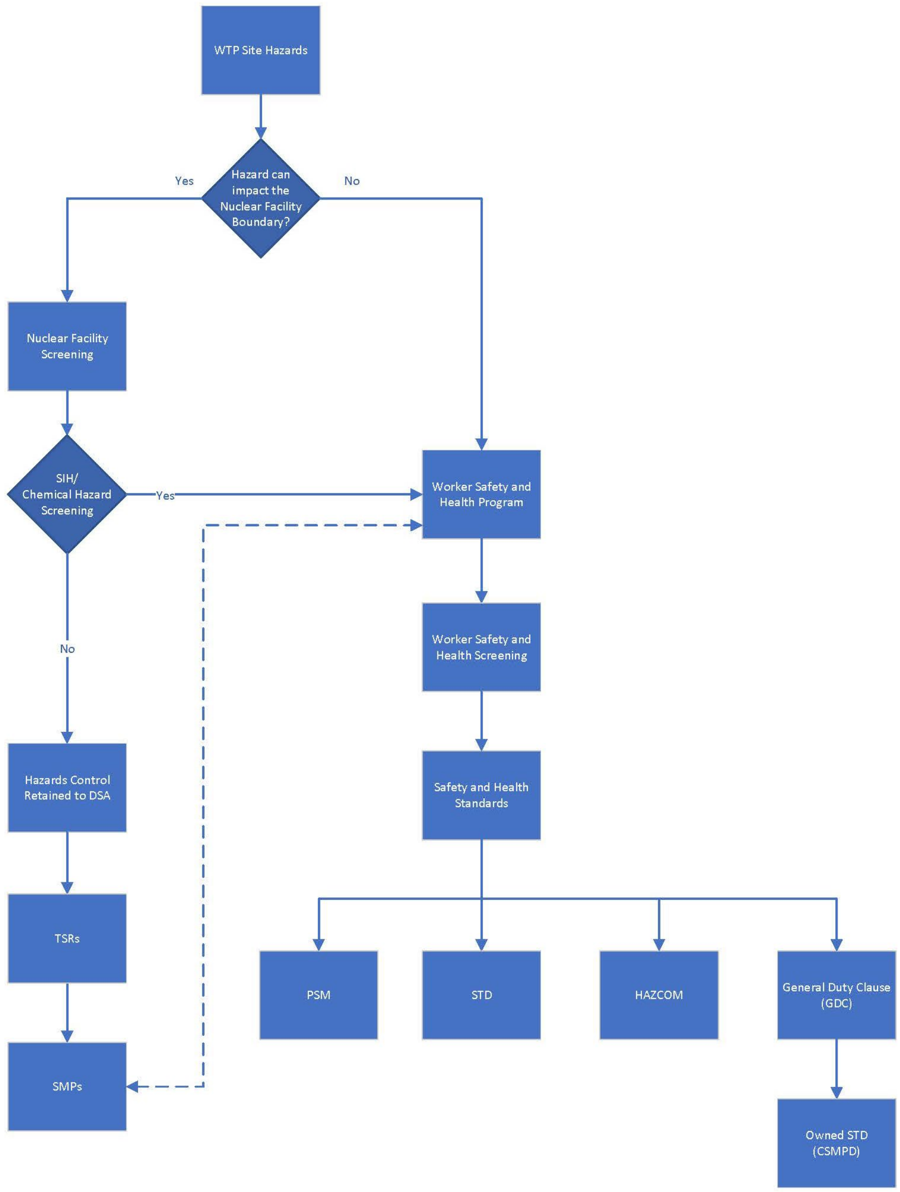
The WTP project will develop a specific stand-alone HLW Facility Chemical Safety Management Program (CSMP), as allowed by safety management program (SMP) guidance in DOE-STD-3009-2014, and using lessons learned from the DFLAW CSMP to address the regulatory requirements, screening criteria results, and necessary control sets. This approach could require revision of many HLW and Lab Facility documents and procedures and/or creation of new documents. The scope of the CSMP will cover all applicable areas of the DFHLW project and will define interfaces with the DFLAW CSMP.

The new chemical safety program will be included in the DOE-approved Worker Safety and Health Program and will include commitments to develop a Chemical Safety Management Program Document (CSMPD).

All hazards within the nuclear facility will be identified and screened for further evaluation within the Preliminary Documented Safety Analysis (PDSA). Standard industrial hazards meeting pre-defined criteria can screen from further evaluation in the PDSA if they are adequately covered by industry codes and standards under 10 CFR Part 851, *Worker Safety and Health Program*, 10 CFR Part 835, *Occupational Radiation Protection* and 29 CFR Part 1910, *Occupational Safety and Health Standards*.

Hazards that are screened from further evaluation will include a specific reference to the industry code or standard that addresses the specific hazard. Hazards outside of the nuclear facility boundary will be identified and controlled under 10 CFR Part 851, *Worker Safety and Health Program* through applicable safety management programs. Hazards external to the nuclear facility boundary, but that can affect the safety basis, are evaluated under the PDSA. The screening process for hazards affecting the nuclear facilities will be further documented in the PDSAs and eventually the respective facility DSAs. Additionally, any controls such as inventory control or access controls that protect the screening assumptions will be included in the PDSAs. The approach for hazard coverage is depicted in Figure 8.

Figure 8 Chemical Safety Hazards Coverage Process Overview



Per DOE-STD-3009-2014, chemical hazards are screened for evaluation by applying the criteria in Section A.2 of the standard. Chemicals that are screened out in this manner still need to be considered for their possible impact on radiological or other chemical accident initiation or progression, or potential adverse impact on safety systems. Chemical properties such as reactivity, toxicity, and incompatibility with other chemicals should be included in the hazard evaluation.

Chemical screening criteria will be based on guidance from DOE-STD-3009-2014 (Section A.2) and DOE-HDBK-1224 (Section 2.2.4 and 9.3), with additional clarification provided by the DOE/Mikolanis memo (CCN 333626), *Updated: Implementation Guidance for Chemical Safety Management*. Screening may be utilized to remove standard industrial hazards (including chemical hazards) including those that coexist with radioactive material, from further consideration in the PDSA/DSA (Chapter 3) when such hazards:

(1) are adequately analyzed/evaluated through 10 CFR 851 and controlled by a safety management program such as the Hazardous Material Protection Program

(2) do not have the potential to initiate or worsen a radiological event

(3) do not have the potential to compromise the ability of facility operators to respond to nuclear events

(4) do not have the potential for significant offsite consequences (i.e., exceeds Protection Action Criteria (PAC-2).

Examples that may be excluded from the PDSA / DSA's hazard evaluations include:

- Chemicals with no known/suspected toxic properties. This exclusion may be claimed when a chemical is not listed in OSHA or EPA toxic chemical regulations or is not assigned a PAC 2 or 3 value on the website of the Subcommittee on Consequence Assessment and Protective Actions.
- Materials that have a health hazard rating of 0 or 1, based on National Fire Protection Association (NFPA) 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, or equivalent ratings from Global Harmonization System of Classification and Labeling of Chemicals.
- Materials that are commonly available and used by the general public, including any substance to the extent it is used for personal, family, or household purposes and that is present in the same form, quantity, and concentration as a product distributed for use by the general public (e.g., bleach, motor oil).
- Small-scale use quantities of chemicals similar to the intent of 29 C.F.R. § 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories* (i.e., containers that are designed to be easily and safely manipulated by one person). A general guideline, as described in DOE Guide (G) 151.1-2, *Technical Planning Basis, Emergency Management Guide*, is individual containers with capacities less than approximately 5 gallons (19 L) for liquids with densities near that of water, 40 pounds (18 kg) for solids (or heavy liquids), or 10 pounds (4.5 kg) for compressed gases, that are handled under the provisions of an identified safety management program such as the Hazardous Material Protection program.

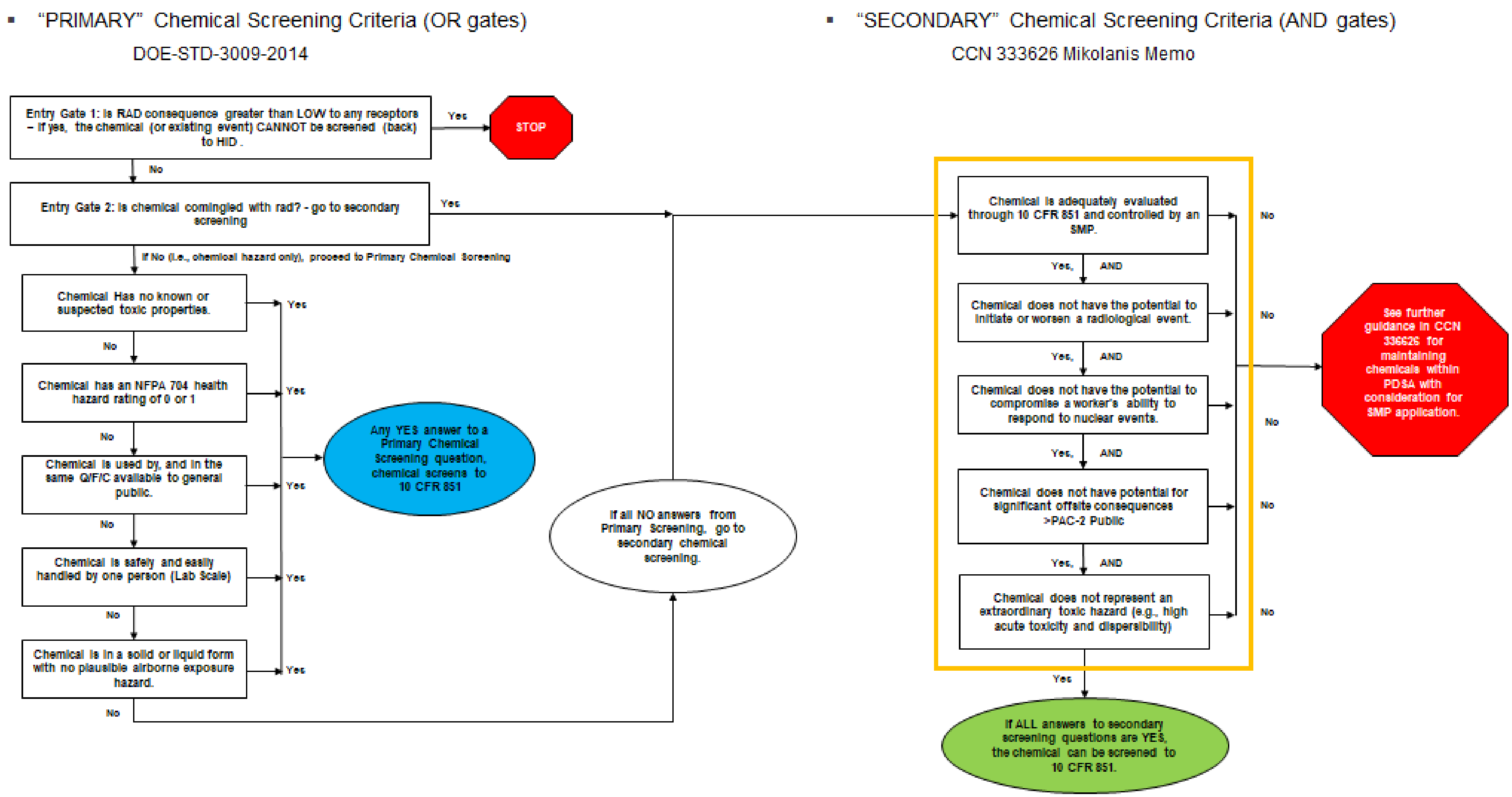
Those chemical hazards not screened out must be evaluated in the PDSA / DSA. These chemical hazards may still be controlled using safety management programs with the following exceptions:

- Chemical hazards with the potential for significant offsite consequences to the public must be controlled with safety significant Structure, System or Component (SSC) or Specific Administrative Control (SAC)
- Chemical hazards that initiate or worsen a significant radiological release must be controlled with safety significant SSC or SAC
- Unique chemicals (e.g., uranium hexafluoride) not addressed by a 10 CFR Part 851 program that could cause significant harm to workers or the public
- Chemicals that affect a nuclear safety function credited in the facility's Technical Safety Requirements (e.g., incapacitating a worker relied upon to perform a credited safety action, or affecting safety-related SSCs)
- Chemical hazards that exceed the DOE-STD-3009-2014 Table 1 Consequences Thresholds must be evaluated for safety significant controls.

Any exceptions to chemical hazards controlled by a safety management program will be included in the Safety Analysis Design Guide.

Screening of chemicals that exceed the above criteria may be managed by a hazardous material protection program (i.e., CSMP) and do not impact nuclear safety. The approach for chemical screening is depicted in Figure 9.

Figure 9 Chemical Hazard Screening Process



In the current Analytical Laboratory administrative control program, protection for the Facility Worker (FW) is achieved through the implementation of various WTP Safety Management Programs (SMPs) such as those documented in 24590-WTP-GPP-RACW-CH-0002, *Chemical Management Process*; and engineered features of the as-built facility. These implement the applicable federal requirements and national codes and standards that govern the hazards present during DFLAW operations. The Industrial Hygiene Program, Hazardous Material Protection SMP, and Chemical Management Program ensure that chemicals are procured in easily handled weights or volumes that meet the criteria that allow screening. In support of DFHLW it is anticipated that the hazard categorization of the Lab Facility will change to HC-3 with the administrative control program being augmented to ensure that the required engineering controls and/or safety significant systems are in place.

Table 3 below lists the chemical constituents that are a subset of the chemical hazards existing in the HLW Facility that are most impacted by the screening approach described above. Those excluded are either those which more obviously screen out due to small quantities, present insignificant hazards, or are screened in due to their higher concentrations of radioactive materials. It is expected that the chemicals used in the Lab Facility would not screen to DSA coverage or to CSMP coverage. However, the formal screening process will be conducted as part of the next revision to the Lab PDSA and associated hazards analysis. The chemicals listed in Table 3, with the exception of the offgas stream within the C5V boundary, would screen from further evaluation in the PDSA and would be covered by the CSMP and/or a separate Worker Safety and Health Program such as Hazard Communications (HazCom) depending on the specific chemical hazard. It should be noted that the secondary offgas does not have a radiological constituent of concern due to the HEPA filtration on the offgas system and C5V boundary. Secondary offgas could be treated under a CSMP consistent with the LAW Facility.

Table 3 Major Chemicals Impacted by Screening

Chemical	Type	Quantity	Location	DOE-STD-3009-2014 Screened	DOE Chemical Safety Screened (Ref. 12.84)	DOE-HDBK-1224-2018 Screened	Program (DSA, PSM, CSMP, HazCom)
Melter Offgas	Gas	554 scfm per melter	C5 (Primary)	No	No	N/A	DSA due to Rad component
Melter Offgas	Gas	554 scfm per melter	C2/C3 (Secondary)	Yes	Yes	N/A	CSMP or DSA – Credit of HOP HEPA filters reduces radioactive concentrations to insignificant levels of radioactive materials.
Anhydrous Ammonia Vapor	Gas	157 g/s into HLW (0.18 g/s HOP) 2.1 kg/h into SCR (0.66 kg/hr. HOP)	C2/C3	Yes	Yes	Yes	PSM due to connection to BOF ammonia system which exceeds PSM threshold quantities.
Hg in carbon adsorber	Gas /Solid	C2/C3 – Accumulated in Carbon Bed media (158 kg per vessel in two years)	C2/C3	Yes	No	N/A	CSMP, although DSA TSR needed to protect initial condition for limiting accumulation
Cerium Nitrate 0.5M	Liquid	2 × 55 gal drums	C5 and C2/C3	Yes	Yes	N/A	HazCom
Nitric acid 2M	Liquid	1300 gal	C5 and C2/C3	Yes	Yes	N/A	CSMP
Sodium hydroxide 5M	Liquid	1400 gal	C5 and C2/C3	Yes	Yes	N/A	CSMP
Laboratory Chemicals	Liquid	Varies	C5 and C2/C3	TBD	TBD	TBD	Individual chemicals to be evaluated based on quantity and consequences.

3.7.6 Worker Safety through Design

The Worker Safety through Design (WStD) program identifies potential workplace hazards (e.g., physical, chemical, biological, industrial safety hazards) associated with the design, and in conjunction with the Industrial Safety program, identifies controls for both project primary phases/activities (i.e., engineering, procurement, construction, and commissioning), and eventual plant operations. The WStD program identifies and assesses the design of the HLW Facility and associated equipment for potential workplace hazards. Additionally, the program will establish and implement a hazard prevention and abatement process to ensure that controls are incorporated in the design to address hazards identified in the facility design. The program selects hazard controls based on the following hierarchy:

- Hazards are either eliminated or substituted by design
- Engineered controls are implemented
- Work practices and administrative controls are implemented (via processes and procedures) that limit worker exposure to hazards
- Workers are provided with personal protective equipment (PPE)

The program addresses the requirements set out in 10 CFR 851.21(a)(4), 10 CFR 851.22 (a) & (b).

3.7.7 Radiological Safety

Radiological Safety is implemented via two distinct program scopes: operational radiological controls, and Radiological Engineering. Radiological Engineering implements "as low as reasonably achievable (ALARA)" throughout the design to manage occupational exposure to ionizing radiation and controlling the release of radioactive materials to levels that meet the applicable requirements in 10 CFR 835 and the WTP Contract. The specific requirements of 10 CFR 835 which address ALARA are 10 CFR 835.101I, 102, 103, 104, 204(d)(3), 704(b), 901(c), and Subpart K, *Design and Control*. Program description 24590-WTP-PD-RADA-RE-0001, *Radiological Engineering and ALARA for Design* describes the implementation of applicable design requirements of Title 10 Code of Federal Regulations (CFR) 835, Occupational Radiation Protection. The Radiological Engineering program includes procedures, guides, ALARA design reviews, ALARA Committee meetings, calculations, training requirements, ALARA design criteria, ALARA optimization and other processes which are defined in 24590-WTP-PL-NS-01-002, *RPP-WTP Occupational ALARA Program for Design*.

Operational radiological control implements remaining aspects of 10 CFR 835, *Occupational Radiation Protection*. The operational radiological controls elements of 10 CFR 835 include but are not limited to: dosimetry, surveys & area monitoring, portable & fixed instrumentation requirements, entry controls, records, area postings & labeling, record control, training, control of sealed radioactive sources and other management & administrative controls.

3.7.8 Criticality Safety

The purpose of the Criticality Safety program is to ensure that operations remain subcritical under all normal and credible abnormal conditions. The existing criticality safety program for the HLW Facility implements DOE O 420.1C, Change 3 (24590-HLW-PD-RACS-CS-0001, *HLW Criticality Safety Program*). Updated and additional criticality safety evaluations will be performed (see Section 9.7) to account for the change in feed and feed delivery to the HLW Facility and changes to processes that do not include the PT Facility, including operation of the Lab Facility. If criticality is determined to be credible in the HLW Facility, the PDSA will evaluate an unmitigated criticality scenario to verify the radiological consequences to the CLW are < 100 rem and low to the offsite receptor, consistent with guidance in DOE-STD-3009-2014, Section

3.1.3, "Criticality Hazards". The preliminary criticality safety evaluation for HLW operations considers Lab Facility operations under pretreatment configuration, any changes due to direct feed will be included in updates to the HLW CSER as the design matures.

4 Safety System Support Interfaces

The WTP Project facilities interface with each other, both physically and administratively. These interfaces include utilities, fire protection, emergency preparedness, waste management, and WTP material transfers. WTP Project programs are in place to ensure that interactions with other facilities and their safety requirements do not affect the WTP Project facilities' safety basis and do not exceed the safety analyses requirements.

Currently as stated in the HLW Facility PDSA (24590-HLW-PDSA-NS-24-0001), the HLW Facility interfaces with several other WTP facilities, including the PT Facility, Lab Facility, and BOF. As a result of the proposed change to implement the DFHLW approach, the new design does not consider the PT Facility and an alternative feed delivery system from the Tank Farms is to be used. Interfaces with the Lab Facility will be evaluated as part of the respective PDSAs and ultimately incorporated into the Lab Facility DSA. The new SSCs and support systems associated with this change will be evaluated to ensure they meet design requirements and their intended safety functions. New interfaces will be formed, and other new buildings/systems may provide support for the direct feed delivery that is yet to be determined. For major assumptions see Section 3.

The HLW Facility control room (FCR) provides a centralized monitoring and control location for operations. The FCR includes operating and monitoring for HLW systems (including programmable protection system (PPJ), process control system (PCJ), etc.), service and utility operations, communications with other WTP facilities and the Hanford site, and shutdown indications and initiations, etc. HLW Facility data will be routed to the WTP main control room, which may need to be relocated from its current location in the PT Facility.

There are many safety systems within the HLW Facility that interface with each other. Specific interfaces are anticipated to change as a result of incorporation of design changes to the HLW Facility. Details on facility interfaces can be found in Section 4 of the HLW Facility PDSA (24590-HLW-PDSA-NS-24-0001).

5 Safety Strategy

The DFHLW Project utilizes a safety and hazard control strategy consistent with DOE-STD-1189-2016 and follows the hierarchy of control selection as follows:

"After hazardous material minimization/elimination and application of inherently safer design concepts where practical, a control strategy shall be (a) selected to prevent or mitigate releases of hazardous materials and to provide defense in depth, and (b) based on the following order of preference:

- *SSCs are preferred over administrative controls.*
- *Passive SSCs are preferred over active SSCs.*
- *Preventative controls are preferred over mitigative controls.*
- *Controls closest to the hazard may provide protection to the largest population of potential receptors, including workers and the public.*
- *Controls that are effective for multiple hazards can be resource-effective."*

For example, the hazard control strategy for the HLW Facility begins with initial conditions that have been defined to limit the amount and type of hazardous materials allowed within the HLW Facility that minimize hazardous materials while allowing the facility to complete its mission in a safe manner. The next hazard control is the primary confinement of hazardous materials which includes piping and in-line components, vessels, equipment boundaries, and primary ventilation systems.

An additional hazard control includes robust secondary confinement, which is provided for all radioactive material processing areas. The C5 passive confinement boundary provides shielding for the facility worker and prevents the worker from being within the immediate vicinity of radioactive and hazardous materials as the processing areas within the C5 confinement boundary are all remote operations.

Both primary and secondary confinement provide passive hazard control but are also supported by active HEPA filtered ventilation systems that exhaust gases to an elevated release point. Numerous preventive systems are also credited to reduce the likelihood of releases within the confinement boundaries, including vessel agitation and ventilation/purge features to prevent the buildup of explosive concentrations of hydrogen gas. These SSCs are supplemented with additional administrative programs to further reduce the likelihood of hazardous material releases.

A similar strategy will be utilized for the Lab Facility when in DFHLW operations. Initial conditions for various postulated hazardous events will be documented in both the HLW and Lab PrHAs.

Following requirements of DOE-STD-1189-2016, the hazards and accident analyses, and control selection approach consider the following principles:

- Inventories of major project hazards
- Potential Consequences of major hazards
- Safety Design Criteria (applied to the project)
- Safety-in-Design approach and philosophies
- Criteria definition and general approach for safety functional classification

In particular, the hazards identified, and their associated unmitigated consequences, may potentially drive safety classification of systems, structures, or components, seismic and other natural phenomena design categorization, overall approach to facility confinement and fire protection, major safety functions, and the potential need for emergency power for safety purposes.

Wherever applicable, interfaces between the HLW Facility and the Analytical Laboratory will be evaluated under the same safety and hazard control strategies consistent with DOE-STD-1189-2016.

5.1 Hazard Categorization

Initial assessment of radiological hazards for the HLW Facility was performed in compliance with DOE-STD-1097-92, Change notice No. 1. The HLW Facility is identified as hazard category 2 facility as documented in 24590-HLW-Z0C-U10T-00001, *Initial Hazard Categorization for the HLW Facility*. It is anticipated that the hazard categorization of the HLW Facility will remain the same with the proposed change to the DFHLW approach. It is anticipated that the revised WAC may yield lower specific activity levels, which could in turn lower the hazard categorization with equivalent waste volumes in the HLW Facility.

The Analytical Laboratory is identified as a Less than Hazard Category 3 facility in the present configuration. It is anticipated that the hazard categorization of the Lab Facility will change to an HC-3 facility to support DFHLW operations.

5.2 Safety Control Strategies

5.2.1 Inherently Safe Design and Hazard Minimization

Consideration of inherently safe design focuses on reducing or eliminating potential hazards and risks at the source, designing a process or system to be inherently safe, rather than relying solely on passive or active safety features to manage those hazards. This can be achieved through a variety of means, such as reducing the quantities of hazardous material, minimizing the potential for fires and explosions, simplifying the process design, and designing for ease of maintenance. In addition to reducing the potential for hazardous events to occur, using inherently safe design can also reduce the severity of accidents and minimize the impact of any accidents that occur. The design process will evaluate and consider inherently safer design concepts that can lead to the removal or reduction of hazards before controls need to be developed.

For example, the hazard mitigation philosophy for the HLW Facility is to reduce the level of hazardous materials and the effects of those materials at the source, and thereby mitigate any effects on workers, the environment, or the public. This concept ensures that exposures are kept to the lowest levels and within the limits set by governing authorities (i.e., Occupational Safety and Health Administration [OSHA] permissible exposure limits and American Conference of Governmental Industrial Hygienists threshold limit values, internally defined occupational exposure limits, and limits defined by DOE directives). Procedures, instructions, and standards ensure exposures are kept to a minimum based on the requirements and provisions of DOE regulations, OSHA regulations, national consensus industrial hygiene standards, and recommended practice. This same philosophy will be applied to minimize hazards in the Analytical Laboratory.

Hazardous material exposures are minimized using the following methods:

- Elimination or substitution of the hazards
- Engineered controls, where feasible and appropriate
- Alerts and self-protection training
- Material identification, verification, and segregation.
- Personnel barricades.

Policy 24590-WTP-G63-RAWS-WS-0001, *Hanford Tank Waste Treatment and Immobilization Plant Worker Safety and Health Policy*, is designed to promote a safe and healthy work environment. The policy is implemented by a combination of collaborative actions by the WTP management team and the WTP project employees and subcontractors, including actions such as:

- Developing, maintaining, and improving the Project's safety and health goals, work practices, and procedures.
- Supporting employee involvement in hazard identification and analysis
- Supporting and ensuring compliance with safety and health regulations and Project safety and health goals, work practices, and procedures.
- Ensuring that hazards are identified, evaluated, and abated, to the extent feasible and appropriate.

The Worker Safety and Health Program (24590-WTP-WSHP-ESH-18-00001) documents the requirements necessary to comply with applicable sections of 10 CFR 851. The methods of compliance are provided, forming the primary implementation foundation for the WTP Project worker safety and health structure. The document provides the primary upper-tiered requirements and identifies or references the mechanisms implementing the requirements, to include specific implementing procedures, policies, and program documents.

5.2.2 Seismic and Other Natural Phenomena Design Categorization

The HLW Facility structure and other SSCs with a safety function, as well as the Lab Facility, are designed following the guidance of DOE-STD-1020 to ensure compliance with the NPH requirements of DOE O 420.1C, Change 3, (see Section 6.1.2). The HLW Facility and Lab Facility structures are designed to withstand the design basis natural phenomena and to the appropriate seismic category (e.g., snow, ash, precipitation (rain), wind and seismic loads) commensurate with the failure consequences of each SSC. The HLW Facility SSCs that have a role in preventing or mitigating releases of radiological and chemically hazardous material are also designed to withstand design basis natural phenomena (e.g., seismic loads). The design strategy is to ensure that SSCs in the HLW Facility (including the building structure) will be designed so they will perform their credited safety functions during and after design basis NPH events.

A review of the seismic design of the HLW Facility, considering changes made to the codes and standards over more than two decades, confirmed that the analysis and design remain valid. The conservatism adopted in seismic input motion, method of seismic analysis, and processing of seismic responses for design clearly show a sizable margin as shown in computed demand and capacity ratios of key walls and slabs in the HLW Facility (see 24590-HLW-TB-MGT-23-0007, *HFFT Decision – Workstream 2.4 Code of Record Team, Seismic*). Similarly, the in-structure response spectra developed for design and qualification of equipment within the structure are conservative, particularly considering the reduction of seismic input motion from the previously used design response spectra compared to the most updated seismic hazard analysis at the site.

The HLW Facility is currently designed to Seismic Category I (SC-I) for earthquakes and Performance Category 3 (PC-3) for other natural phenomena hazards (NPH), which is conservative given the existing HLW Facility seismic event consequences are less than 5 rem to the public. PDSA revision 12 reclassified SC controls as SS to align with the current consequences and the requirements of DOE-STD-3009-2014. This change resulted in the recategorization of most existing SC-I/SC-II SSCs to SC-III. This change does not result in a decrease in the pedigree of equipment already installed. Some of the SSC reviewed in the reclassifying process retained their existing SC-I/SC-II levels for non-nuclear safety driven requirements.

The existing operating Lab Facility is currently designated to SC-III/PC-2 for earthquakes and NPH, respectively. The Lab structure is classified as Safety Significant (SS). Subsequent to this revision of the

SDS a Lab specific PDSA will be developed to appropriately classify SS controls as required to align with anticipated consequences during DFHLW operation as a HC-3 facility. The development of this PDSA will follow the requirements of DOE-STD-1228-2019. The PDSA will evaluate the proper categorization of existing SC-I/SC-II and SC-III SSCs with a focus on any required recategorizations to accommodate DFHLW support operations, facility interfaces, and use of the hot cells. It is anticipated that the development of the PDSA will not result in a decrease in the pedigree of equipment already installed however reclassifications may require promoting existing SC-III SSCs to SC-I/SC-II levels for non-nuclear safety driven requirements.

Implementation of DOE-STD-1020-2016 invokes determination of limit states applicable only to those support facilities designed to DOE-STD-1189-2016. The Analytical Laboratory is an existing operational facility designed under DOE-STD-1020-1994 for NPH design and evaluation.

As discussed in Section 3.7.1, the HLW Facility will be designed to DOE-STD-1020-1994 wherein limit states are not required. The process to identify limit states is in development and would be performed following hazards analysis.

5.2.3 Confinement Strategy

To maintain control over sources of radioactive or dangerous waste, confinement barriers protect FW, CLW, the public, and the environment. The number and arrangement of these confinement barriers and their required design features are determined on a case-by-case basis in each facility. Engineering evaluations and experience are used to determine confinement system boundaries.

Ventilation systems in building areas containing radioactive materials are sized based on a low-flow ventilation philosophy, to determine the amount of air required to meet the design requirements for the facility space (for example in the Lab Facility cooling requirements for the hotcells and face velocity for Lab fume hoods). The minimum amount of air required to pass through a space is determined to be that which must be drawn through penetrations in the space boundary to minimize the spread of contamination. After this criterion is applied to establish minimum flow velocities, other factors, such as heat removal or dilution effects, are considered to meet the space requirements and properly size the ventilation systems.

5.2.3.1 HLW Facility Confinement Strategy

The HLW Facility confinement strategy is achieved through primary and secondary confinement.

Primary confinement is achieved by passive boundaries that form the closest layer of confinement for the radiological or hazardous material. Examples are process vessels, piping, PVV system, and the HOP system that form a primary confinement barrier during normal operations of process systems. If the primary confinement fails, releases are mitigated by the secondary confinement.

Secondary confinement is provided by a combination of passive and active features, including the process cells (walls, floors, ceilings) and their associated ventilation systems. The majority of the nuclear safety hazards are located within the safety significant C5V active confinement system boundary. The HLW Facility active confinement ventilation systems support facility passive features by directing room airflow through a differential pressure gradient between rooms and equipment that contain radioactive material. The differential pressure creates a cascading effect used to control the spread of contamination by ensuring that building air flows from less contaminated areas to more contaminated areas (cascading airflow).

As the HLW Facility design matures, the safety design basis development will follow the confinement requirements of DOE O 420.1C, Change 3, Attachment 2, Chapter 1, considering the hierarchy of controls recommended in DOE-STD-3009-2014 to address changes such as new waste feed delivery. The strategy will consider both primary confinement (i.e., process piping, vessels) and secondary confinement (active ventilation).

5.2.3.2 Analytical Laboratory Confinement Strategy

Passive confinement is maintained by two confinement boundaries, the Hotcell Confinement Boundary and the C5 Effluent Vessel Cell Confinement Boundary. The Hotcell Confinement Boundary consists of the hotcell structure (including shield doors and shield windows that penetrate the structure), the hotcell receipt station docking unit components that provide confinement, and the hotcell gloveboxes. The C5 Effluent Vessel Cell Confinement Boundary consists of the C5 effluent vessel cell and the hotcell drain collection tank pump and valve pits. These boundaries provide bulk confinement of radionuclides for worker protection.

The active designs of the HVAC systems allow pressure gradients to be established that flow (“cascade”) air from less contaminated areas to areas of greater contamination potential. Four general confinement zones are established and referred to by contamination zone classification designators.

- C5 areas include process enclosures and their ventilation systems. C5 areas may be highly contaminated, and human occupancy in these areas is not normally allowed. Access to C5 areas and equipment designated as C5 areas is allowed with controls established under the Radiation Protection Program
- C3 areas may have low levels of contamination due to the work processes in them. Areas within the Lab Facility ventilated by the C3 ventilation system include the rad labs through the fume hoods, C3 maintenance shop, lab pack room, volume reduction room, and the C5 pump maintenance area. The C3V exhaust system maintains the desired negative pressure in the C3 areas relative to C2 areas
- C2 areas are maintained uncontaminated but are adjacent to contaminated areas and might become contaminated from these sources. C2 areas provide the secondary confinement for C3 and C5 areas. The C2 ventilation supply system provides the required heating, cooling, and humidification for indoor environmental control. It is also necessary for the establishment of the design pressure gradients in the building, to ensure the flow of air from areas of least contamination potential, C2, towards the areas of the greatest contamination potential, C5
- The C1 designator is reserved for support areas outside the radiological areas. C1 areas are expected to remain free of contamination

5.2.4 Fire Prevention and Mitigation Strategy

A Fire Hazards Analysis (FHA) was prepared that provides an area by area evaluation of the process facilities and the associated fire hazards, fire prevention, combustible loadings, and fire consequences. Fire prevention and mitigation in the HLW Facility and the Analytical Laboratory are accomplished through implementation of methods and features of fire protection. These methods and features combined with the programmatic aspects of the WTP Fire Protection Program, prevent or mitigate the propagation of fire until arrival of emergency response personnel and meet Highly Protected Risk (HPR) requirements for both facilities. The fire mitigation strategy relies on both passive and active fire protection systems.

The baseline fire mitigation strategy relies primarily on passive fire protection features for building separation, structural fire protection, and fire area separation as provided by fire-rated construction. The active fire protection consists of active systems such as fire detection, fire alarm, fire water supply, fire suppression, portable fire extinguishers, and ventilation systems interface. Features include:

- Building separation to provide discontinuity of combustibles between buildings and prevent the propagation of fire into an enclosed fire area, until arrival of emergency response personnel (applies to exterior fire area separation).

- Fire barriers to prevent the propagation of fire from one fire area to another, until arrival of emergency response personnel (applies to interior fire area separation).
- Installation of non-combustible material to the extent practical, in accordance with DOE requirements, building, fire, and consensus codes and standards.
- Control of transient combustibles
- Automatic suppression systems to prevent the propagation of fire within an enclosed fire area, until arrival of emergency response personnel (applies to interior fire area protection). Fire water supply and suppression systems are designed to control fire growth and limit fire spread to the room or fire area of origin.
- Fire detection and alarm system that provides early warning and notification of fire within an enclosed fire area, to summon the Hanford Fire Department and allow personnel to exit safely (applies to interior fire area protection).
- Portable fire extinguishers are used when appropriate for manual extinguishment of small fires.
- Vehicles used for transport within the building are limited to those that do not use combustible or flammable liquid or gas fuel sources.
- HLW Facility fire safety is also predicated on the programmatic aspects of operating procedures and Inspection, Testing, and Maintenance (IT&M) to ensure the proper controls and reliability are maintained for the life of the facility.
- A confinement boundary of fire resistive construction to mitigate the consequences of a release of radioactive and chemically hazardous material by confining this material within the physical confinement boundary.
- Ventilation systems that assist in limiting smoke spread by the shutdown, isolation, and cascading design features of the HVAC system.
- The WTP site is designed so that there are no in situ exposure fire hazards near either the HLW Facility or the Lab buildings. Neighboring buildings are separated from the HLW Facility and Lab buildings and do not represent an exposed fire hazard.
- Consistent with applicable building separation criteria, the exterior walls of the building are of noncombustible and non-rated insulated metal panels.
- The HLW Facility is constructed of non-combustible materials and is classified as a Type IB fire-resistive structure in accordance with the IBC.
- The Lab building is classified as a Type II B structure in accordance with the International Building Code. Where structural failures could affect Safety SSCs, the fire resistance of structural steel members will be analyzed to determine the need for fireproofing.

Lessons learned from the LAW Facility will be incorporated into updates to the DFHLW Project fire prevention and mitigation strategies and documented in revisions of the fire hazards analysis. A separate fire hazards analysis for the Lab Facility will be revised to reflect impacts, if any, to DFHLW support operations.

5.2.5 Flammable Gas Control Strategy

The flammable gas of primary concern in the HLW Facility is hydrogen generated as a product from the waste in the feed prep and melter feed vessels. Hydrogen explosions are controlled by a combination of preventive and mitigative measures, with the primary controls being the following:

- HFP vessel headspace dilution / purge air

- HFP vessel mixing (agitators)
- Ventilation (C5V; cascading)

During normal operations HFP vessel headspace low flow purge with continuous vessel agitation precludes a hydrogen explosion by maintaining the headspace concentration below 25% of the Lower Flammability Limit (LFL) at the maximum hydrogen generation rate.

During off-normal events (i.e. agitator failure) high flow purge initiates to preclude greater than LFL conditions during normal releases and limit time at risk during an episodic release. These functions may be accomplished through the use of alternate equipment (e.g. portable /staged equipment). The off-normal events include NPH such as seismic and ashfall.

The agitators are required to be qualified to seismic level SC-III to maintain agitation.

Ammonia is also recognized as a flammable gas of concern that poses a hazard to the FW. Protection is offered by facility design features that provide confinement, shielding, and impact protection, along with ammonia flow detection, restriction, and interlocks that regulate the ammonia feed.

For the Lab Facility, administrative controls (AC) are utilized for the quantity and form of organic liquids allowed in the hotcells to prevent accumulation of flammable organic vapors, aerosols, and transient combustibles. This AC heightens attention to the need for Lab Facility compliance with the fire protection program, and specifically with ensuring that the combustibles are controlled to within quantities identified in the accident analysis, and that only limited quantities of certain types of materials be present in the hot cell to preclude accumulation of flammable organic vapors. The program must also limit the disposal of organic wastes to the RLD system to protect an initial condition assumption in the hazard and accident analyses. The hazard analysis assumes organic wastes sent to the C5 RLD vessel are within analyzed bounds.

5.2.6 Direct Radiation Control Strategy

Primary radiological hazards of concern include the process material and the glass in melters and canisters. The radiological control strategy is implemented primarily through engineered controls. Engineered ALARA features (such as shielding designs, backflow preventers, cascade ventilation, etc.) enable annual dose exposures for facility workers to be less than allowable radiological exposure levels to comply with 10 CFR 835, *Occupational Radiation Protection* (Subpart K, §835.1001 and §835.1002). Direct radiation exposures are controlled by application of the shielding design criteria and formal calculations. Shielding design criteria are established in 24590-WTP-DC-ENG-19-001, *Shielding Design Criteria for WTP Offset and Straight Through Penetrations, Shadow Shields, and Embedded Pipes/Conduits and Radioactive Process Piping.*

Control of contamination at the source (e.g., confinement, containment, remote handling) is accomplished via ALARA design criteria throughout the facility (e.g., permanent containment structures, shielding, and cascade ventilation systems). Application of ALARA design criteria mitigates the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions. Controls prescribed use a graded approach that is dependent upon factors that include (but are not limited to) the type and level of contamination present, other activities in and around the area, and work area occupancy factors.

Control of airborne radioactive material is achieved via confinement and ventilation. Areas with higher potential for airborne contamination have the lowest negative ambient air pressure such that air cascades from adjacent areas with lower potential for airborne contamination. This engineering method controls and mitigates the inhalation of such material by workers to levels that are ALARA.

The Radiological Engineering Program Description, 24590-WTP-PD-RADA-RE-0001, *Radiological Engineering and ALARA for Design*, describes the implementation of design requirements applicable to engineering, procurement, and construction (EPC) phases mandated by Title 10 Code of Federal Regulations (CFR) 835, *Occupational Radiation Protection* and 24590-WTP-RPP-ESH-01-001, *Radiation Protection Program for Design, Construction, Commissioning and Operations* (RPP). The elements for establishing and operating an ALARA program that complies with 10 CFR 835 are described in 24590-WTP-PL-NS-01-002, *RPP-WTP Occupational ALARA Program for Design*.

The Radiological Engineering Program Description delineates the responsibilities and activities required to maintain occupational exposure to ionizing radiation and the release of radioactive materials to levels that meet the applicable requirements and guidance in 10 CFR 835 and the Contract through facility design, including ALARA implementation. These requirements are applied throughout the design of the HLW Project as described in 24590-HLW-3DP-G03B-00001, *HLW Design Process*.

The ALARA design considerations and actions, provided in 24590-WTP-3DI-W12W-00002, *Application of ALARA in the Design Process* are implemented in the design and are also applied as appropriate throughout EPC, commissioning, and startup phases of the project. The implementation of ALARA is based on the determination of the practicable controls for the specific situation, which includes either formal or informal optimizations of the design (see 24590-WTP-3DI-W12W-00002, *Application of ALARA in the Design Process,* Section 5.3.3). Optimization implies formal or informal cost benefit analyses (CBA) that considers:

- radiation dose,
- cost (including schedule impacts)
- other risks
- societal benefits

Thus, the guidelines, rules, goals, and targets associated with ALARA are subject to the selection of alternative approaches if there is a documented ALARA evaluation that justifies the change, unless specifically required in 10 CFR 835 or the WTP contract. This is the industry accepted method of adapting a graded approach for implementation of ALARA in nuclear facilities. Justification for selection of specific ALARA features is documented in 24590-WTP-RPT-ENS-13-004, *ALARA Optimization Report*. The ALARA cost benefit process is implemented throughout design phases on a graded approach and utilizes the ALARA hierarchy of controls, which prioritizes the most effective controls while considering overall cost. The ALARA hierarchy of protective measures is:

- Prioritization of alternative agents and processes – removal or minimization of the hazard
- Physical design features – engineered into the facility (e.g., shielding & backflow preventors)
- Operational safety features - operational management controls and administrative controls applied to reduce exposure to the hazard during both routine operation and maintenance. These controls concentrate on methods and conduct of work and are generally less effective than physical design features (e.g., temporary barriers, work planning to minimize exposure time)
- Personal Protection Equipment (PPE) – PPE is not recognized nor relied upon when designing the facility.

Formal quantitative ALARA cost benefit analyses are utilized on a graded approach following the process established in Appendix A of 24590-WTP-3DI-W12W-00002. The CBA seeks to determine the option with the minimum total cost where total cost is defined as the sum of the monetary cost of the option, versus the monetary value of the collective dose and other benefits. This requires a monetary value of a unit of collective dose to be established. The CBA documents how the factors affecting a protection decision (i.e., social, technical, economic, practical, and public policy) are assigned values to compare detriment and benefits. It is not expected that a CBA be used as the primary driver in every ALARA decision.

Documentation of a CBA is required only when the decision process hinges on this methodology. Subject matter expert judgment, supported by cross-functional review, is an acceptable alternative to a formal CBA. Final approval of the design drawings/records coupled with the formal ALARA Design Review Record is sufficient documentation to fulfill radiological protection program requirements. A CBA is one type of record supporting the ALARA analysis, and, depending on the particulars of the situation (the formality and degree of quantitative analysis reflects the scale and type of problem under consideration), issuance of a formal CBA is not required in order to arrive at an appropriate decision.

5.2.7 Criticality Control Strategy

The preliminary criticality control strategy for the HLW Facility is based on limits on fissile constituent (co-precipitated Pu and Uranium) parameters in the feed to be received. This strategy will be protected with the limits of the WAC SAC. The preliminary strategy is anticipated to develop a waste acceptance limit to be implemented through the final WAC SAC to verify that the incoming feed meets a limit on the ratio of Pu to iron equivalent mass. The nature of the HLW Facility processes do not separate, segregate, and accumulate fissile material from the other process material or enrich it. Preliminary limits in the WAC SAC will provide assurance that a criticality accident is not credible for the feed evaluated (see Section 9.7 for criticality control strategy). As this strategy is contingent on the WAC parameters it will be monitored and is further included as Risk 1 in this SDS.

The other concern for criticality safety at the HLW Facility is what is referred to as heavy Pu particulates (HPP). The HPP exists in a small subset of tanks. An evaluation of HPP and criticality control strategy for HPP is to be determined. This evaluation may demonstrate that a criticality from HPP is not credible in the HLW Facility. As design and process conditions based on the new feed and feed delivery to the HLW Facility are matured, the criticality safety evaluations for the facility will also be matured. Risks 1 and 2 identify these potential impacts to the criticality evaluation and control strategy.

The preliminary control strategy for the Lab Facility is based on samples received into the Lab Facility containing the same materials evaluated for the processing facilities. It is anticipated that, as these samples have been shown to be safe in the processing facilities, they would be safe in the Lab Facility. The nature of Lab Facility processes also do not separate, segregate, and accumulate fissile material from the other process material or enrich it. This approach will be evaluated as additional information is obtained (e.g. HPP input described above). Receipt of samples from sources other than WTP processing facilities to be analyzed within the Lab Facility is not a planned operation and would be evaluated on a case-by-case basis for the need for criticality controls (Risk 13). The preliminary criticality safety evaluation of the Lab Facility will also be updated alongside design maturation of the HLW Facility.

5.2.8 Ashfall Control Strategy

The natural phenomena hazard (NPH) ashfall event involves a volcanic event causing ashfall to the Hanford site that results in the potential loss of offsite and emergency backup power to the HLW facility, thus challenging the continued operations of SS systems such as C5V ventilation and vessel agitation and headspace purge. The proposed ashfall hazard control strategy is based on a facility risk reduced configuration with a minimal set of credited controls maintained operational to mitigate the hydrogen gas hazard in the HFP vessels.

The risk-reduced configuration approach involves stopping melter feed, transfers, or movement of radioactive or hazardous materials, and activities within the C5 areas to minimize unfiltered openings, thereby reducing the likelihood of a release of material and material at risk during a loss of power or ventilation to the HLW Facility. While in a risk-reduced configuration, flow reversal through remaining unfiltered openings has been evaluated to be of low consequence.

During the evaluated ashfall event immediate actions are initiated for deployment of HFP agitator power and HFP purge compressed air sources to provide vessel headspace purge (for headspace accumulation) and intermittent agitation (to prelude episodic releases) leading to a flammable HFP vessel headspace. Provisions for operating these systems at their required capacities (typically fuel) are maintained for at least 10 days. Staged/portable equipment may be utilized to provide vessel headspace purge and/or temporary power. Operational areas for post-ashfall support equipment should be selected to allow for operation without additional ash protection attributes (filters/baghouses) as much as possible.

The ashfall strategy for the Lab Facility is anticipated to be controlled using a similar risk-reduced configuration methodology.

5.2.9 Industrial Hazards Strategy

The approach to workplace hazards (e.g., physical, chemical, biological, industrial safety hazards) identifies potential hazards associated with the design, and in conjunction with the worker safety and health program, identifies controls for both project primary phases/activities (i.e., engineering, procurement, construction, and commissioning), and eventual plant operations. Potential workplace hazards are identified and assessed through the design of the DFHLW Project and associated equipment. Additionally, the project will establish and implement a hazard prevention and abatement process to ensure that controls are incorporated in the design to address hazards identified in the facility design. This approach and associated programs address the applicable requirements set out in 10 CFR 851.21(a)(4), 10 CFR 851.22 (a), (b), and (c).

5.2.10 Anticipated Safety Functions

The HLW Facility and associated SSCs and support systems are in different stages of design maturity. Therefore, the information here does not explicitly list the controls and their specific safety functions, but rather the overall general philosophy of what is anticipated as safety function for major hazards identified in the HLW Facility during construction and operation. The HLW Facility has an issued PDSA (24590-HLW-PDSA-NS-24-0001), which will be realigned with the requirements of DOE-STD-1189-2016. Safety design basis development will also follow the DOE STD-3009-2014 requirements and hierarchy of designated controls for overall control strategy and safe design. This enables the HLW Facility to systematically adopt inherent safety in design.

The Lab Facility including associated SSCs and support systems needed for DFLAW operations are design complete and operational in support of the DFLAW project, however many of the SSCs needed to support DFHLW operation remain in the design and construction phase. As with the HLW Facility, the information here does not explicitly list the controls and their specific safety functions, but rather the overall general philosophy of what is anticipated as safety function for major hazards identified for the Lab Facility during construction and operation while in DFHLW support operations. The Lab Facility has an issued PDSA (24590-WTP-PSAR-ESH-01-002-06) and a HAR (24590-LAB-HAR-NS-18-0001) to support construction authorization and DFLAW operations, respectively. The Lab Facility PDSA will be updated in alignment with the requirements of DOE-STD-1189-2016. Safety design basis development will follow DOE-STD-1228-2019 requirements and hierarchy of designated controls for overall control strategy and safe design (passive engineered over active, engineered over administrative, etc.) as pertinent for those portions of the facility modified and operated to support DFHLW.

The HLW Facility PDSA lists certain postulated fire, explosion, loss of confinement, seismic, and NPH events as events that pose a moderate concern for the public and designates safety controls. These are events that fall under the Risk II (medium risk) ranking in an unmitigated scenario. Medium risk is defined as having either High (significant) consequence and Extremely Unlikely frequency or Moderate consequence and Unlikely or Anticipated frequency. Protection of the public, CLW, and FW are ensured with the identification and designation of safety class SSCs, safety significant SSCs, SACs, and SMPs where or if applicable. The forthcoming Lab Facility PDSA will also list the events, risk rankings, identifications, designations, and protective controls to ensure the protection of the public, the CLW, and the FW.

Safety significant controls, which will apply to both the HLW Facility and the Lab Facility, such as process piping, vessels, HFP vessel agitators, HFP vessel purge piping, melter shell, ammonia piping and flow restriction, and confinement ventilation are identified to either prevent, mitigate, or provide confinement for the hazardous material. Some of the SACs include waste acceptance criteria, ashfall response, loss of HFP vessel agitator or purge, and critical lift. The SMPs that provide other layers of protection include the following:

- Chemical Safety Program - ensures that FWs handling hazardous chemicals are trained and use appropriate personal protective equipment (PPE)
- Conduct of Maintenance Program - ensures that hazardous maintenance procedures, including the movement and exchange of compressed gas bottles, are conducted with appropriate job controls.
- Conduct of Operations Program - ensures that procedures are developed and FWs receive appropriate training to follow procedures and respond to events.
- Emergency Preparedness Program –
    - provides notification and/or alarms for external events that may affect HLW including ammonia
    - releases plans event response actions
    - post-seismic fire protection water response to determine recovery actions necessary to address the potential for excessive facility flooding that could be caused by fire suppression water following a severe seismic event (exceeding SC-III)
- Fire Protection Program - prevents the introduction of significant quantities of transient combustibles in confined areas, requires the installation and maintenance of automatic fire suppression, fire detection, and fire alarm systems
- Hoisting and Rigging Program - ensures that all FWs conducting lift activities are trained, and that all equipment used is inspected and maintained
- Maintenance Program - ensures that SSCs are regularly inspected and maintained to work as designed, including procedures to limit introduction of combustible materials and control potential ignition sources to prevent fires during maintenance activities
- Radiation Protection Program - controls FW access to higher radiation areas and conducts regular surveillances of SSCs which provide shielding and confinement
- Worker Safety and Health Program - responsible for equipping and training workers for job hazards, including the handling of spent carbon bed media
- Quality Assurance - Chemical procurement is governed under the Quality Assurance SMP (Procurement / Supplier Quality) and Industrial Hygiene processes where receipt of improper reagent can be noticed and rectified

Current controls with their detailed safety functions and functional requirements are documented in Table M-1, Appendix M of the HLW Facility PDSA. As the result of implementation of the HLW Facility SDS, the safety design basis documents including the PDSA and associated PrHAs will be reassessed to ensure the selection of controls and criteria are aligned with the requirements of the updated DOE standards and to address any potential new design or modifications such as direct feed delivery from Tank Farms (instead of PT Facility). As part of this reassessment, the waste acceptance criteria will also be revisited to ensure it appropriately and adequately protects the receptor and meets the design specification for SSCs and support systems in the HLW Facility.

Anticipated controls, if any, with their detailed safety functions and functional requirements will be documented in the revised Lab Facility PDSA. The safety design basis documents including the PDSA and associated PrHAs will be reassessed to ensure the selection of controls and criteria are aligned with the requirements of the updated DOE standards and to address any potential new design or modifications such as supporting DFHLW operations.

Preliminary accident analysis demonstrated that the consequences of receiving direct feed from Tank Farms are reduced due to multiple factors including the feed having a lower unit dose (24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development*). With the change in feed properties with a direct feed methodology it is anticipated that no safety class controls will be required. The parameter values needed to maintain the conclusions in 24590-HLW-ES-NS-23-001 will be protected within the waste acceptance criteria.

Table 4 HLW Facility Significant Hazards and Hazard Control Approach

Hazard	Credited Passive Primary Confinement	Confinement Ventilation	Additional Preventive Controls	Additional Mitigative Controls	Credited Initial Conditions
Waste Feed - Liquid with Toxic and Radioactive Constituents	• SS HFP/HCP Process Piping, Jumpers, Vessels, and In-line Components	• SS C5V Active Confinement and HEPA Filtration		• SS C5 Confinement	• WAC SAC
Melter Glass - Molten Liquid with Toxic and Radioactive Constituents	• SS Melter Shell Confinement Boundary	• SS C5V Active Confinement and HEPA Filtration	• SS Melter Pressure Relief Device	• SS Shielded C5V Confinement Barrier	• WAC SAC
Melter Offgas - Gas with Toxic and Radioactive Constituents	• SS HOP Confinement Boundary	• SS Active C5V Confinement and HEPA Filtration	• SS SBS Low-Level Interlocks • SS HOP Interlocks	• SS HOP Interlocks • SS HOP HEPA Filtration • SS Shielded C5V Confinement Barrier	• WAC SAC
Melter Offgas - Secondary Offgas, Gas with Toxic Constituents	• CS HOP Confinement Boundary	• DiD C3V Active Confinement	• SS SBS Low-Level Interlocks • CS HOP Interlocks	• CS HOP Interlocks	• WAC SAC
Nitric Acid (2M) - Corrosive Liquid	• CS Piping, Vessels, and In-line Components	• DiD C3V Active Confinement	• CS Pressure Relief Devices	• N/A	• N/A
Sodium Hydroxide (5M) – Corrosive Liquid	• CS Piping, Vessels, and In-line Components	• DiD C3V Active Confinement	• CS Pressure Relief Devices	• N/A	• N/A
Ammonia - Toxic Gas, Flammable Gas, Corrosive	• CS Piping and In-line Components	• DiD C3V Confinement	• CS HOP Interlocks	• CS HOP Interlocks • CS Ammonia Detection, Isolation, and Alarm	• N/A
Hydrogen Generation - Explosive Hazard (release of toxic and radioactive waste feed)	• SS Piping, Vessels, and In-line Components	• SS Active C5V Confinement and HEPA Filtration	• SS HFP Vessel Air Purge • SS HFP Vessel Agitators	• SS Shielded C5V Confinement Barrier	• WAC SAC

Table 4 HLW Facility Significant Hazards and Hazard Control Approach

Hazard	Credited Passive Primary Confinement	Confinement Ventilation	Additional Preventive Controls	Additional Mitigative Controls	Credited Initial Conditions
Mercury – Toxic Vapor	• CS Carbon Bed Confinement Boundary (CS Secondary Offgas System)	• DiD C3V Confinement	• CS Offgas High Temperature Interlock		• Mercury Loading Control (Carbon Bed Media Replacement Frequency)

Note – This table provides a summary of the predominant hazards within the HLW Facility as extracted from the PDSA and general control approaches for each hazard. This table is not a full list of facility hazards or controls, which are listed in their entirety in the HLW Facility PDSA and PrHA.

Table 5 Analytical Laboratory Significant Hazards and Hazard Control Approach

Hazard	Credited Passive Primary Confinement	Confinement Ventilation	Additional Preventive Controls	Additional Mitigative Controls	Credited Initial Conditions
HLW Sample Handling	• Hot Cells • C5 Vessel/Piping	• C5	• N/A	• N/A	• Inventory Limits
LAW Sample Handling	• N/A	• N/A	• Rad Lab Hoods • C3 Vessel/Piping	• C3	• Inventory Limits
Chemical Reagent Storage and Use	• N/A	• C3/C5	• N/A	• Safety Management Programs	• N/A
Inert Gas Receipt/Storage/Transfer	• N/A	• N/A	• Exterior storage vessels Oxygen Monitoring	• Safety Management Programs	• N/A

Note – This table provides a summary of the predominant hazards within the Analytical Laboratory for both DFLAW and DFHLW operations. This table is not a full list of facility hazards or controls, which will be listed in their entirety in the Lab Facility PDSA and PrHA.

5.3 Guiding Philosophies & Major Assumptions

The DFHLW Project is in mid-construction with SSCs and support systems in a variety of completion stages. For many years DOE-STD-3009-94 was followed as one of the major guiding philosophies for safety and design, augmented by the DOE direction in 15-NSD-0017 (CCN 281177). The DFHLW Project has committed to implement both DOE-STD-1189-2016 and DOE-STD-3009-2014 and although no major impacts are anticipated, re-evaluation of safety design basis development and safety design basis documents, including existing PrHAs, is necessary. Specific guidance and requirements are listed in Section 6.

With the anticipated reclassification of the Lab Facility as a Hazard Category 3 facility, the PDSA will have to be revised utilizing the safe harbor methodology of DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities.* As with the HLW Facility, re-evaluation of safety design basis development and safety design basis documents, including existing PrHAs, may be necessary for the Lab Facility to support DFHLW operations.

Through evolution of the WTP project it was decided that the PT Facility will not be considered in the DFHLW approach. This has major impacts on the process and assumptions that were previously considered for the HLW Facility. For example, the proposed method for feed delivery to HLW Facility is direct delivery from Tank Farms through a new waste transfer vault. This change requires evaluation to identify the potential for new hazards and/or requires changes to the WAC to ensure the HLW Facility can perform its design and safety function. Additionally, design and operation of the HLW Facility will be impacted to accommodate the new feed delivery system. Major assumptions are:

- Any support or function that is attributed to PT Facility is assumed to not be utilized
- New waste stream feed will be delivered from the Tank Farms or an intermediate facility

Considering the above assumptions, major impacts that have been identified include the following:

- Many support systems and utilities may need to be rerouted to meet HLW Facility needs. For example, BSA, CHW, DOW, PSW, fire protection water system (FPW), LPS, lighting electrical system (LTE), LVE, etc. could be affected since they are supporting the HLW Facility in processing waste streams from the Tank Farms. Some of the impacts may include addition of new structures, vessels, piping, etc.
- With PT Facility not considered in the DFHLW approach, waste feed will be supplied to the HLW Facility from a different location than PT Facility, which could affect design and operating conditions associated with the waste transfer to the HLW Facility (e.g., the design, operation, and location (proximity to the HLW Facility) for the waste feed transfer pumps will be impacted. Additionally, some PT Facility systems/functions that will no longer be available for use will require design and construction of new systems to replace functions that were to be provided (e.g., waste feed transfer, RLD effluent, the main control room (MCR), PPJ interfaces to MCR annunciators, safety ISA, etc.)
- Waste feed supplied to HLW Facility may have different feed characteristics such as particle size. Therefore, the ability to sample and analyze the feed is highly dependent on the incoming waste stream which could impact mixing design, transfer line design, and any other identified system(s).
- Implementation of the Analytical Laboratory facility to support DFHLW operations will require a careful transition of the design and safety basis to ensure that no adverse impacts to ongoing DFLAW operations occur.

For detailed discussion of risks and opportunities see Section 9.

5.3.1 Safety-in-Design Approach

In general, the DFHLW Project control strategy involves control of accidents by preventing hazardous conditions, or, if preventive measures are infeasible, by confining releases of MAR within the facility boundaries. The primary accidents identified for the DFHLW Project facilities include large facility fires, hydrogen or ammonia explosions, mechanical failures of equipment (e.g., pipe break), accidental worker exposure to high-radiation areas, and failure of facility equipment and/or structures due to earthquakes, ashfall loading, or facility flooding. The HLW Facility control strategy manages these accidents collectively by employing multiple layers of controls.

- The facility is built using appropriate architectural methods to resist failure due to excess weight, wind loading, and seismic motion.
- The facility is built in a fashion such that the highest-hazard materials are flowed through confinement rooms built to isolate and recover liquids, as well as provide radiation shielding.
- All waste processing (where the predominant hazards reside) are within robust, shielded, access controlled rooms. Many of these rooms are completely inaccessible to workers, precluding certain worker related hazards.
- Permanent plant equipment is designed to perform its function with required service intervals for the design life of the plant. Equipment will be designed and installed to the appropriate seismic rating.
- Hydrogen explosions are prevented by ensuring that the waste feed vessels remain mixed during normal operations, which releases trapped gases, and vented/diluted using forced air flow, which prevents accumulations of the released gases within the feed vessel.

For the HLW Facility, the waste feed is the MAR of highest concern due to both its constituents and the potential for it to evolve explosive hydrogen gas. As the waste feed is processed in the melter system, different waste streams are produced (e.g., molten glass, offgas, process condensate, solid adsorbents). Additionally, chemically hazardous materials are used in the process as reactants or for decontamination. These waste streams and chemically hazardous materials have various consequence levels to the FWs and CLWs within the Hanford Site, and the public outside the Hanford site boundary.

Hazards will be revisited to assess any changes to the facility and inform design as the project progresses. Hazard evaluation will include evaluating changes associated with the new proposed draft WAC and changes associated with the shift to a direct feed approach for the HLW Facility. The design parameters associated with direct feed and associated transfer SSCs will be evaluated to ensure consequences from waste feed spray release events in the HLW Facility remain within the currently evaluated limits. A new WAC specific administrative control (SAC) TSR could also protect the evaluated parameters to ensure that analyses remain valid, ensure that the bounds of the source term are protected, and protect the analytical assumptions and basis from which the credited SSCs and SACs have been evaluated to perform or to adequately control a hazardous event. For clarity, WAC SAC parameters will be established for the feed characteristics only, and not the pipe line sizing, pump pressures, etc.

Typically, a CSDR is written for the conceptual design phase of a project, but due to the project maturity of the HLW Facility, changes and new information are being captured in this SDS and in future revisions of the HA and PDSA as described in Section 1.2 Project Scope. One missing piece from the HA and PDSA that will be captured that would normally be in a CSDR is security hazards and design implications. The Safeguards and Security Program will update their existing facility evaluations as necessary to address the new design and operations of the HLW Facility and address applicable requirements from the DOE order 470 series. These evaluations will inform design, the HA, and PDSA.

For the major modification to the Lab Facility the CSDR approach is similar. It is anticipated that the content requirements of a CSDR are met by existing documentation in the HA and PDSA. Security hazards and design implications are expected to require supplementary information to achieve the expected content of a CSDR but are forecast to be completed in parallel with the HLW Facility security documentation.

5.4 Commitments to DOE O 420.1C, Change 3

DOE O 420.1C, Change 3, will be implemented as required by the contract between DOE and BNI.

5.4.1 Design Requirements

The design requirements of DOE O 420.1C, Change 3, will be implemented in the HLW Project as described in Section 3.1.1. Specific codes and standards to be used for the design of the safety SSCs are identified in the Code of Record and any tailoring needed is captured herein in Section 6.1.

5.4.2 Approved Exemptions

As described in Exemption (9) of DOE O 420.1 C, Change 3 the design requirements of the latest change do not apply to projects that have reached a high level of design maturity. Full construction authorization of the WTP site (CD-3) has been approved; therefore, the HLW Facility is a high level of design maturity. This exemption in 420.1C, Change 3 is invoked to reduce impacts on the existing design and mitigate unnecessary project costs. This exemption is applied only to the HLW Facility. The details of the application of this exemption is described in Sections 6.1.1 and 6.1.2

There are no other requested exemptions to the requirements of DOE O 420.1C, Change 3, identified. If the need for an exemption is later identified, it will be presented to DOE for approval and will be captured in subsequent revisions to this SDS once appropriate approvals are received.

5.4.3 Approved Equivalencies

There are currently no approved equivalencies to the requirements of DOE O 420.1C, Change 3, identified. If the need for an equivalency is identified as design progresses, it will be presented to DOE for approval and will be captured in subsequent revisions to this SDS.

5.4.4 Analytical Laboratory Approach

The Analytical Lab structure is fully constructed and implementation of the major modification scope will not impact the existing footprint of the facility. The facility structural design was performed to DOE-STD-1020-94. The design spectra in DOE-STD-1020-94 are fully bounding of the spectra in DOE-STD-1020-2016 as reviewed in 24590-HLW-TB-MGT-23-00007 Rev 0 *HFFT Decision – Workstream 2.4 Code of Revord Team, Seismic*. Based on this, the implementation of the DOE O 420.1C, Chg 3 through the PDSA is tailored to permit the continued use of DOE-STD-1020-94 for existing structures. This tailoring allows for a common approach to the legacy constructed facilities of both HLW and Lab, however, the grading approach is only invoked for Lab (Section 5.4.2 describes the approach for HLW).

5.5 Atmospheric Dispersion Modeling Protocol

Consistent with DOE-STD-3009-2014, the atmospheric dispersion factors (χ/Q) used for evaluation of the public receptor consequences are determined using the DOE-approved toolbox code MACCS2 and applying conservative parameters per "Option 3" as listed in Section 3.2.4.2 of the Standard. CLW χ/Qs concerning radiological and hazardous chemical releases will be determined based on site and/or HLW Facility characteristics as the approach is warranted per Section 3.2.4.2 and 3.2.4.3 of the Standard.

A WTP site specific atmospheric dispersion modeling protocol developed for CLW χ/Qs was approved by the DOE under letter CCN 336729 (23-NSD-0042). In this communication the DOE approved the use of that atmospheric dispersion modeling protocol as defined in 24590-HLW-RPT-NS-23-001, *Atmospheric Dispersion Modeling Using ARCON96 for Co-located Worker (CLW)*, which is the proposed implementation for the HLW Facility. A revision to this protocol is also being planned and will be submitted for approval along with the HLW Facility PDSA revision being implemented under DOE-STD-1189-2016. Use of ARCON96 for dispersion modeling is only approved for determining CLW consequences, no use of ARCON96 related to public consequences is requested or approved at this time.

The Lab Facility may follow the same approach, codes, and standards that are applicable to HLW Facility in developing atmospheric dispersion factors, pending further evaluation.

6 Safety Guidance and Requirements

The DOE provides design guidance and requirements for nuclear facilities through the Code of Federal Regulations, the WTP contract, Orders, technical standards, and guides. This section presents those documents as they will be applied to the DFHLW Project.

An evaluation of the legacy codes and standards and the updated versions has been performed to determine the appropriate version that will be applied to the HLW Facility design going forward. The evaluation is contained in the series 24590-HLW-ES-ENG-22-004, *Code of Record Evaluation – HLW Firm the Foundation (Volumes 1 – 11)*, that is used to obtain alignment with Project Stakeholders and establishes the basis for an update to the Code of Record.

The approach for tailoring of standards is generally described in this section. This list may be modified in future revisions if additional tailoring is needed. Approved tailoring of standards will be captured in project requirements documents. Tailoring does not imply the omission of requirements in the acquisition process or other processes appropriate to a specific project's requirements or conditions.

Tailoring does not apply to nuclear safety requirements, which utilize a "graded approach" as prescribed in 10 CFR Part 830, Nuclear Safety Management. The "graded approach," defined in 10 CFR 830.3 and repeated in DOE-STD-1189-2016, is used instead of tailoring for activities managed under 10 CFR 830. This approach also applies to DOE Standards such as DOE-STD-3009-2014 and DOE-STD-1189-2016 used to meet requirements driven by 10 CFR 830. Any application of "Tailoring" or the "graded approach" must include the basis for their use in the corresponding deliverable. This requirement is addressed herein, clarifying that the use of "Tailoring" represents the application of the "graded approach", and the application of DOE O 413.3B, Change 6 on "Tailoring" is adequately addressed by using the "graded approach".

6.1 DOE O 420.1C, Change 3, Design Requirements

The WTP HLW Facility is committed to the design requirements of DOE O 420.1C, Change 3. DOE O 420.1C, Change 3, contains the requirements for design of DOE facilities which includes both the design criteria and the consensus standards that must be evaluated to determine applicability. Recategorization of the Lab Facility to an HC-3 nuclear facility may require that modifications to the design meet the requirements of DOE O 420.1C, Change 3. An assessment will be performed to determine applicability to the Lab Facility.

Compliance with DOE O 420.1C, Change 3 is documented in Table 6 and Appendix C of this document.

Specific application of invoked and referenced standards from DOE O 420.1C, Change 3, is described below.

6.1.1 Invoked Standards

The following standards shall be met as written:

- DOE STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* (HLW Facility)
- DOE-STD-1228-2019, *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities* (Lab Facility)
- DOE-STD-1189-2016, *Integration of Safety into the Design Process*
- American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8 Nuclear Criticality Safety Standards (as described in the Criticality Safety Program)

The following standard has detailed implementation as described below based on Exemption 9 of DOE O 420.1C, Change 3.

- DOE-STD-1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*.

6.1.2 Application of DOE-STD-1020

The DFHLW Project moving forward shall utilize multiple editions of DOE-STD-1020.

- DOE-STD-1020-94 is applicable to the HLW Facility. The tailoring of DOE-STD-1020-94 is documented in Appendix C. Exemption 9 of DOE O 420.1C, Change 3 is invoked as described below and in section 5.4.2
- DOE-STD-1020-94 is applicable to Analytical Laboratory as graded in Section 5.4.4. The tailoring of DOE-STD-1020-94 is documented in Appendix C.
- DOE-STD-1020-2016 is applicable to HLW Support Facilities

See section 6.1.3 for definition of HLW Facility and HLW Support Facilities. The details of the tailoring of DOE-STD-1020 can be found in Appendix C.

For the HLW Facility, DOE O 420.1C, Change 3, Exemption 9 is invoked in regard to DOE-STD-1020. Critical Decision 3 (CD-3) was approved by DOE (CCN 057394) in April 2003, which authorized full construction for the WTP. Since approval, work on the HLW Facility was intermittently paused while technical and funding issues were resolved. During this timeframe the focus of the WTP project shifted to DFLAW startup and commissioning.

The Analytical Lab structure is fully constructed, and implementation of the major modification scope will not impact the existing footprint of the facility. Based on this, the implementation of the DOE O 420.1C, Chg 3 through the PDSA is tailored to permit the continued use of DOE-STD-1020-94 for existing structures.

Modification of the requirements to current standards would be significantly impactful at the current maturity stage of design and construction. The HLW Facility structure is approximately 50% complete, from –31 ft elevation basement level up through the 37' elevation slabs and walls to the 58' elevation. Seismic considerations in the design were already adopted and implemented DOE-STD-1020-94 up to and including this stage of construction. Adjusting requirements at this point may incur significant revisions without commensurate benefit.

6.1.3 Attachment 3 of DOE O 420.1C Change 3 Standards

Definition/Discussion of HLW Facility vs. HLW Support Facility

The DFHLW Project moving forward will utilize multiple editions of the same Code/Standard. The COR will specify the edition to be used in each area. For the purpose of tailoring, when the tailoring specifies "HLW Facility" it is meant to be building 30, and do not include the add-ons that are to be completed after issuance of 24590-WTP-COR-MGT-18-00001, Rev. 3 (e.g., Melter assembly and RWH building add-on, and new facilities would follow the new editions of the codes). HLW support facilities (e.g., electric BOF steam plant, Melter assembly, RWH building add-on) are facilities that are not designed or built prior to issuance of 24590-WTP-COR-MGT-18-00001, Rev. 3.

Note 1 As identified in DOE O 420.1C, Change 3, Attachment 3 standards are proposed to be updated to the modern versions in order to align with supplier requirement and industry capabilities.

Note 2: For codes and standards listed in the table below, if the edition year is stated, the edition years specifically identified in the version proposed for use shall be implemented as designated and as directed.

If the code year is not specified (designated as "Current Edition") for a code or standard listed in the COR then the code year specified in the design, or the most recent code year in effect at time of procurement or construction, shall be used. Editions of applicable requirements shall be documented in the appropriate design documents. Disciplines may invoke additional codes and standards, or reference information provided they do not conflict with the EPC COR.

Table 6 Standards from DOE O 420.1C, Change 3, Attachment 3 (HLW Facility)

Code / Standard	Version in DOE O 420.1C, Change 3	Current Edition (Note 2)	Detailed Tailoring Required (App. C)	Justification and Applicability (Note 1)
Structural				
ACI-318	No edition specified	1999	Y	Applicable to HLW Facility
		2022	Y	Applicable to HLW Support Facilities
ACI-349	2006	2001	Y	Applicable to HLW Facility
		2013	Y	Applicable to HLW Support Facilities
ANSI/AISC 360	2010	Current Edition	N	Listed in the HLW Facility COR without specific date
ANSI/AISC N690	2012	1994	Y	Applicable to HLW Facility
		2018	Y	Applicable to HLW Support Facilities
Mechanical and Process Equipment				
ASME BPVC, Section VIII, Division 1 or 2	2015	Current Edition	N	Listed in the HLW Facility COR without specific date
API-620	2013	Current Edition	N	Listed in the HLW Facility COR without specific date
API-650	2013	Current Edition	N	Listed in the HLW Facility COR without specific date
AWWA D100	2011	Current Edition	N	Listed in the HLW Facility COR without specific date
ASME B73.1	2012	2020	N	
ASME B73.2	2003 (R2009)	2016	N	
Hydraulic Institute Standards	(as applicable)	Current Edition	N	The HLW Facility COR lists HI 9.6.2 without specific date
ASME B31.3	2014	Various	Y	
API 520 substituted for ANSI N278.1	1975	API 520	Y	WTP actuated valve and relief valve work processes (guides, datasheets, and specifications) already meet the intent of this standard. For Relief valves, the HLW Facility COR and work processes already apply API 520, *Sizing, Selection, and installation of Pressure-Relieving Devices in Refineries*, which provides comprehensive recommended practices related to pressure-relief devices.

Table 6 Standards from DOE O 420.1C, Change 3, Attachment 3 (HLW Facility)

Code / Standard	Version in DOE O 420.1C, Change 3	Current Edition (Note 2)	Detailed Tailoring Required (App. C)	Justification and Applicability (Note 1)
TEMA B, C, or R	9th Edition 2007	Current Edition	N	Listed in the HLW Facility COR without specific date
AGS-G006	2005	Current Edition	N	Listed in the HLW Facility COR without specific date
Ventilation				
ASME AG-1	2015	1997 (2000)	Y	
		2019	Y	
Mechanical Handling Equipment				
CMAA Standards	(as applicable)	Current Edition	N	CMAA 70 listed in the HLW Facility COR
		Current Edition	N	CMAA 74 listed in the HLW Facility COR
ASME NOG-1	2010	Current Edition	N	Keep using the 2002 edition for the procured and delivered HLW cranes. Use the most current edition for future HLW crane procurements.
ASME NUM-1	2009	Current Edition	N	Keep using the 2000 edition [with NUM 1a-2002 Addenda] for the procured and delivered HLW cranes. Use the most current edition for future HLW crane procurements.
ASME B30.2	2011	Current Edition	N	Keep using the 2001 edition applied for the procured and delivered HLW cranes. Use the most current edition for future HLW crane procurements.
DOE/RL 92-36 substituted for DOE-STD-1090	2011	DOE/RL 92-36	Y	Operation of the facility uses the Hanford Site Hoisting and Rigging Manual (HSHRM) DOE/RL-92-36 is a site-specific manual which meets the requirements of DOE-STD-1090.
ASME B30 Series	ASME B30.2 2011	Current Edition	N	Keep using the 2001 edition applied for the procured and delivered HLW cranes. Use the most current edition for future HLW crane procurements.
	ASME B30.16	Current Edition	N	Keep using the older editions applied for the procured and

Table 6 Standards from DOE O 420.1C, Change 3, Attachment 3 (HLW Facility)

Code / Standard	Version in DOE O 420.1C, Change 3	Current Edition (Note 2)	Detailed Tailoring Required (App. C)	Justification and Applicability (Note 1)
	(year not identified)			delivered HLW cranes. Use the most current edition for future HLW crane procurements.
	ASME B30.17 (year not identified)	Current Edition	N	
Electrical				
IBC	2021	2021	Y	
IEEE-308	2012	2020	Y	
IEEE-338	2012	2012	Y	
IEEE-379	2014	2014	Y	
IEEE-384	2008	2018	Y	
IEEE-323	2003 (R2008)	Current Edition (*)	Y	Superseded by IEEE/IEC 60780-323- 2016 (* of the IEEE/IEC)
IEEE-603	2009	2018	Y	
IEEE-C37	2010	2010	N	
Instrumentation, Control, and Alarm Systems				
ANSI/ANS-58.8	1994 (R2001) (2008)	2019	N	
ANSI N13.1	2011	Current Edition	N	COR has ANSI/HPS N13.1, Sampling and Monitoring Releases of Airborne Radioactive Substances From the Stacks and Ducts of Nuclear Facilities
ANSI/ISA Series including:				
• ISA 67.04.01	2006 (R2011)	2018	Y	
• ISA TR 84.00.01 Part 1	2004	2018 *	Y	* ANSI/ISA 61511-1 Supersedes ISA-TR 84.00.01 Part 1
IEEE-N42.18	2004	Current Edition	N	
DOE-STD-1195	2011	2011	Y	

Table 7 Standards from DOE O 420.1C, Change 3, Attachment 3 (Lab)

Code / Standard	Version in DOE O 420.1C, Change 3	Current Edition (Note 2)	Detailed Tailoring Required (App. C)	Justification and Applicability (Note 1)
This table will be updated in a future revision to the SDS when needed to support design completion of Lab for DFHLW.				

6.1.4 Code Tailoring Evaluations

Code Tailoring Evaluations were performed as part of several studies whose purpose is two-fold:

- Develop tailoring of DOE orders/standards and industry codes/standards that are contained in the HLW Facility COR to support the next HLW COR revision
- Perform a review of items that are currently tailored to determine if any adjustments are required based on the results of the HLW Facility COR Engineering Study

DOE O 413.3B Change 6, *Program and Project Management for the Acquisition of Capital Assets,* discusses tailoring:

> *Tailoring is necessary for efficient delivery of projects and should be applied to all projects considering size, complexity, cost, and risks. Tailoring does not imply omission of requirements, and requirements must be addressed to the extent necessary and practical.*

24590-HLW-PD-RAQA-QA-0002, *HLW Graded Approach* describes tailoring as “the process of identifying or adapting a requirement for applicability to the Project”.

The code tailoring evaluations for those directly cited in DOE O 420.1C, Change 3, are contained in Appendix C. All of the detailed evaluations for tailoring are contained in references 12.13 to 12.18.

7 Hazard Identification

This section provides a brief description of the hazard screening process and a summary of current identified hazards and potential hazards that will be evaluated as a result of the proposed changes (see Section 1.1) for the HLW Facility. Revision 1 of the SDS introduces a summary of existing and anticipated hazards for the Analytical Laboratory (Lab Facility) is included with consideration for potentially being reclassified as a HC-3 facility.

Hazards associated with the HLW Facility processes have been identified and evaluated, as shown in the existing PDSA (24590-HLW-PDSA-NS-24-0001) and associated hazard analysis (24590-HLW-ES-NS-20-001). Commensurate with the strategy proposed herein, a PDSA will be developed for the Lab Facility in accordance with DOE-STD-1228-2019.

The HLW slurry feed is composed of a mixture of liquids and solids containing both radiological and chemical hazards. The maximum anticipated radiological composition of the HLW feed is based upon a Waste Acceptance Criteria (WAC) specifying maximum radionuclide activity. The feed produces hydrogen that poses a hydrogen explosion hazard. Glass formers are added to waste feed, mixed, and pumped into the melter. The molten glass has both radiological and chemical hazards in addition to the thermal hazard.

Both the primary and secondary offgas system contain hazards associated with the melter offgas, and hazards associated with offgas treatment systems. The radiological hazards are contained within the primary confinement boundary inside of the C5V area. The offgas goes through multiple filtration systems, including credited HEPA filters before entering the secondary offgas system. The secondary offgas system hazards are limited to chemical hazards from the offgas stream and offgas treatment systems, which include mercury (collected on the carbon bed), nitrogen oxides (NOx), and ammonia.

Sealed HLW canisters are identified as a hazard during transport from the pour caves, during decontamination (several chemicals are used for decontamination including nitric acid, sodium hydroxide and cerium nitrate), storage in the canister storage cave, and during transportation to a storage facility either on or off the Hanford Site. Eventually, the canisters will be shipped to a federal repository for permanent disposal. The spent and/or failed melters utilized in the HLW Facility will be contaminated and a source of radioactive material requiring handling, storage, and disposal.

Hazards exist with processing and handling of secondary wastes (liquid and solid). The radioactive liquid waste disposal (RLD) system receives liquid waste, provides interim storage, and transfers the effluent out of the HLW Facility for treatment, recycling, or disposal. The RLD system utilizes sodium hydroxide for neutralization, which is a chemical hazard. The liquid waste sources include process effluents from the offgas system, the canister decontamination process and vessel wash, and liquid waste from cave washes and drains. Secondary solid waste includes items such as used high-efficiency particulate air (HEPA) filters, carbon filter media, and consumable equipment.

Although specific hazardous material inventories may increase or decrease due to the change to the DFHLW approach, the predominant hazard types remain consistent. In this case the primary hazard scenarios that could lead to a release of MAR from the HLW Facility are large facility fires, hydrogen or ammonia explosions, mechanical failures of equipment (e.g., pipe break), accidental worker exposure to high-radiation areas, and failure of facility equipment and/or structures due to earthquakes, ashfall loading, or facility flooding.

The proposed WAC introduces risks with the specifics of the waste streams internal to the HLW Facility that will be unknown until updated Process Engineering documents are completed. Early analysis of the impacts (due to the proposed WAC) indicates that all existing calculations involving radiological and chemical consequences although impacted, would have consequences reduced.

Hazards impacting FW will be revisited to ensure the level of protection and selection of controls meet the requirements of DOE-STD-3009-2014 (HLW Facility) and DOE-STD-1228-2019 (Lab).

7.1 Hazard Screening Process

With respect to nuclear safety, in 10 CFR Part 830, *Nuclear Safety Management*, a hazard is defined as "a source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to an operation or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation)." To identify potential facility hazards, the following were examined:

- Quantity, form, and location of radioactive and hazardous materials that would be potentially releasable from or within HLW Facility
- Potential energy sources and initiating events that could directly result in injury to workers or lead to release of radioactive or hazardous materials.

Chemical, radioactive, and industrial hazards are identified and screened to ensure all hazards are appropriately evaluated and controlled under proper regulatory framework. All hazards are addressed under 10 CFR 830 – *Nuclear Safety Management*, 10 CFR 851 – *Worker Safety and Health Program*, 29 CFR 1910.1–9 - *Process Safety Management of Highly Hazardous Chemicals*, or 10 CFR 835 – *Occupational Radiation Protection*. The hazard controls are further addressed by specific industry codes and standards applicable to the individual hazards, and those requirements inform the safe design of DFHLW Project facilities and systems. The BOF ammonia system is the only system that contains hazardous material quantities in excess of 29 CFR 1910.119 threshold quantities. A chemical safety management program that is similar to those used by high-performing chemical industry peers will be developed to manage and control chemical hazards associated with the nuclear facility operations.

The hazard screening process identifies the hazards in the facility and adds them to the hazard identification checklist. An initial hazard screening is then performed for each identified hazard using the criteria in DOE-STD-3009-2014 (Sections A.1 and A.2) (HLW Facility) and DOE-STD-1228-2019 (Lab) to determine if a hazard can be screened from requiring further analysis in the respective PDSAs. Hazards screened at this step are not progressed beyond the PrHA to the PDSA/DSA for further evaluation. Control of these hazards is managed under safety management programs, and specific controls are not provided in the PDSA/DSA or CSMP.

Chemical hazards that could otherwise be screened out, that have the potential to be an accident initiator involving radioactive or hazardous material release, or that could compromise the ability of the facility operators to safely manage the facility, are retained as part of the hazard evaluation in accordance with DOE-STD-3009-2014, Appendix A, Section A.2.

The HLW Facility will use anhydrous ammonia for the removal of NOx from the offgas. Offgas and ammonia are known to be hazardous materials of concern for the HLW Facility and are not considered a standard industrial hazard (SIH) or out-of-scope chemical screening. Ammonia is the only on-site chemical which exceeds Process Safety Management (PSM) quantities for chemical safety screening per 29 CFR 1910.119 Process Safety Management of Highly Hazardous Chemicals.

The hazards screening process is described in detail in Section 3.3.1.2.1 of the HLW Facility PDSA. In this process the procedure is to first revisit the initial HID to filter out hazards in line with the guidelines set by DOE-STD-3009-94 Change Notice 3, as elaborated by 15-NSD-0017. The hazards screened out include radiological hazards controlled under 10 CFR 835, standard industrial hazards (SIH) for which there are national standards, and specific chemicals not part of process streams that adhere to a set of conditions such as having no toxic properties, being used in safe quantities and concentrations, or having a health hazard rating of 0, 1, or 2 per NFPA 704. These chemicals should not pose airborne risks due to their physical state or other factors and are therefore removed from consideration.

Hazards identified as SIH, and managed as per national consensus standards, are not included in the What-If analysis if they meet the set standards and have a documented SMP requirement in facility TSRs. The intent of a 10 CFR 830 safety analysis is not to address safety concerning common industrial hazards that largely fall under OSHA regulatory compliance. However, chemicals that are not filtered out by the above criteria undergo the What-If analysis. For hazards that are screened, a review is conducted to ascertain their potential to cause uncontrolled releases of hazardous materials or negatively affect credited controls. Those with such potential are retained for further Hazard Evaluation, alongside items that were not screened initially.

Combustion products resulting from facility fires will not be considered, except for the scenario of the burning of a carbon adsorption unit releasing mercury compounds. This scenario is not considered to be an SIH as it is not routinely encountered in general industry.

8 Key Safety Decisions

This section identifies and describes key safety decisions that have significant cost and schedule implications for the project, as described in the following list. This section also provides items that are either new or deviations from the existing HLW Facility and future Lab Facility PDSAs and are identified for allowance of early design until the PDSAs are created/updated.

1. Proposed WAC parameters that have the potential to affect the safety design basis have been developed and documented in 24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development.* This study identifies parameters that are intended to reduce consequences to receptors, however mission needs and operational considerations at Tank Farms and WTP must be factored in to finalize the nuclear safety related WAC. The results of the impact evaluations of the candidate properties are intended to be further evaluated outside of the engineering study to inform a qualitative review of PrHA and safety basis control selection. Final waste feed parameters will be confirmed with the assumptions in the formal engineering study.

2. Delivery of waste to the HLW facility will be through a proposed vault facility (see Section 9.2) rather than the PT Facility. Physical parameters such as maximum transfer volume, transfer line sizing, and pump pressure has been estimated in 24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development.* Final physical feed parameters will be confirmed with the assumptions in the formal engineering study.

3. New and modified support system facilities and systems as described in Section 2 have been proposed for DFHLW operations. Nuclear facility interfaces with these proposed facilities and systems will be evaluated in the HLW and Lab PDSAs and/or hazard analysis reports. Final determination of the facilities and systems and their associated interfaces will be confirmed in support of design completion.

4. The ashfall control strategy has been updated in the HLW Facility PDSA. The primary approach involves a risk-reduced configuration procedure for the HLW Facility using a minimum set of credited controls to mitigate the hydrogen gas in the High-Level Waste Facility Process (HFP) vessels, using utilities supplied by alternate equipment (e.g. portable staged equipment) to provide air purges to the vessel headspace and power to the vessel agitators.

5. Changes to the Code of Record have been identified and documented in this SDS. The WTP HLW Facility is committed to the design requirements of DOE O 420.1C, Change 3. DOE O 420.1C, Change 3, contains the requirements for design of DOE facilities. Tailoring of DOE O 420.1C, Change 3, Attachment 3 standards, are included in this SDS.

6. Criticality is assumed to be incredible for HLW and Lab Facility operations, and a criticality safety alarm system is not required. Updates to the HLW feed profile for DFHLW operations are not expected to change the incredibility of criticality scenarios. Processing of Heavy Plutonium Particulates (HPP) are also not expected to adversely impact the criticality safety strategy.

7. As unmitigated consequences to the public are below 5 rem, there is not a need for safety-class designation of any structures, systems, and components for DFHLW operations. The HLW Facility PDSA has been revised to change identified safety-class controls to safety-significant. Seismic design requirements for nuclear safety related derivations have been revised to reflect the new safety designation of the affected controls.

8. A Chemical Safety Management Program will be developed to control and manage chemicals that are screened out from further evaluation in Chapter 3 of the HLW and Lab Facilities PDSAs. Additionally, since the hazards associated with the Secondary Offgas System in the HLW Facility are only associated with chemical that will screen out from further PDSA evaluation, it is assumed that those hazards will be further evaluated, controlled, and managed through a Chemical Safety Management Program.

8.1 Authorization for Design of Systems

Items listed in this section are either new or deviations from the existing HLW Facility PDSA. These items are described in this SDS at a high level to allow for design activities to continue. After design has been matured the SDS and PDSA will be updated to include these systems and to authorize construction activities.

This authorization extends to bid, award, and performance of the design activities in design then build contracts or subcontracts. Contracts to be awarded for design before procurement authorization is complete shall include hold points to allow the vendor to be halted pending authorization to proceed with material procurements.

8.1.1 Support Systems for Loss of Offsite Power (NPH & non-NPH)

8.1.1.1 Emergency Power Supply

Provides backup power during loss of offsite power events to safety systems credited to continue to operate after the event. This system shall be designed to the same safety category as the systems it is protecting and to the seismic Design Basis Earthquake (DBE) requirements.

8.1.1.2 Safety Air Supply

Provides air service to maintain a controlled purge on the headspace of hydrogen generating vessels. Air flow is required to protect the time at risk as described in the HLW Facility PDSA, as well as supporting other post-accident functions such as valve actuations. This system shall be designed to the same safety category as the systems it is protecting and to the seismic DBE requirements. The requirements for post NPH safety air supply will be continually evaluated by SDIT and if necessary, options for supplying the safety air will be explored. For example, temporary supply capability could be utilized in lieu of a dedicated Safety Air Supply building. Post-accident valve actuation and performance will be part of this consideration.

8.1.2 Standby Control Room

Requirements for the standby control room as an alternate to the main control room are under development. This facility is intended to provide a standby control location for HLW systems in the event that the primary control room is not available. This may be a standalone building or located in one of the other WTP facilities. It is not required for this facility to be designed for the seismic DBE.

8.1.3 Safety Cooling

The current design and safety basis describe independent cooling systems for rooms containing safety equipment. Safety cooling may be accomplished with individual units, holistic system, or any combination of the two. The purpose of the safety cooling is to maintain the required temperatures in the C1, C2, and C3 rooms containing safety related equipment during Design Basis Events (DBE). This configuration is subject to change as the design matures. Irrespective of the final design, this system shall be designed to the same safety category as the systems it is protecting and to the seismic DBE requirements.

8.1.4 Ashfall Control Strategy

The ashfall safety control strategy has been incorporated into the PDSA. The current strategy is to use low flow purge air from portable air compressors and power generators along with intermittent agitation of the HFP vessel to mitigate hydrogen gas buildup in the vessel headspace and maintain concentrations below the lower flammability limit. Upon failure to maintain required agitation frequencies in any HFP vessel, a high flow air purge is provided to the headspace to reduce the probability of a hydrogen event.

8.1.5 Melter Assembly Bay

Requirements for the melter assembly bay are under development. This portion of the facility is to be constructed on the northside of the existing HLW Facility with the function to assemble new (clean) melters, handle spent melters while in their overpack, and temporarily stage other secondary waste in containers. The waste will not be stored in the melter assembly bay for any permanent amount of time however spent melters placed in boxes will transition through the bay. As the MAR in this facility includes a melter contained in a credited overpack and secondary waste in containers, the structure is expected to be safety significant and designed to the seismic DBE requirements to ensure container integrity is not compromised.

8.1.6 Export Bay

The HLW Facility will be modified to include a new export bay on the northeast side of the facility to reduce reliance on RWH export activities. This new area will process the same MAR as the existing RWH export bay and is anticipated to have the same controls required after completion of formal hazards analysis activities.

8.1.7 Asset Protection Building

The facility will contain utility services to protect assets inside the HLW Facility in case of loss of primary utilities. This facility contains no MAR and as a result is non-safety and has no credited seismic qualification. There is, however, potential that the addition of new utility sources is expected to modify existing hazards analysis scenarios inside the HLW Facility. These changes are expected to be generally extending the existing scenarios to the new utilities and applying appropriate controls within the HLW Facility.

8.1.8 DF (Shielding)

10 CFR 835.1002 identifies design objectives to maintain radiation exposure in controlled areas ALARA. The proposed change to the safety significant safety performance criteria does not impact shielding design to support ALARA and 10 CFR 835 requirements. The dose limit from 10 CFR 835 currently identified in the performance criteria for the Shielding Design Feature (Section 4.1.4.4 of 24590-HLW-PDSA-NS-24-0001) is more stringent than the current design basis of some occupied areas in the HLW Facility. DOE-STD-3009 and 10 CFR 835.1002 both provide independent requirements in design space to protect the FW from high consequences. The difference is that 10 CFR 835 provides design criteria for normal operations in order to meet administrative control limits on dose for areas which could be continuously occupied (2000 hours per year). This inherently protects the FW from high consequences to keep doses ALARA. The current performance criteria in the PDSA is significantly more conservative than what is necessary to protect the facility worker from high consequences. The proposed change to the safety significant

performance criteria does not impact shielding design to support ALARA and 10 CFR 835 requirements. For this reason, the change from the current to revised performance criteria is shown below:

Current Safety Significant Performance Criteria:

> Areas that perform a credited shielding function are designed in accordance with 10 CFR 835.1002, to reduce direct radiation from those areas to adjacent occupied areas below an average of 0.5 millirem per hour.

Revised Safety Significant Performance Criteria:

> Areas that perform a credited shielding function are designed to reduce direct radiation from those areas to adjacent occupied areas below an average of 10 rad per hour at 12 in.

10 CFR 835 is applicable to all doses and all workers. The functional classification of SSCs as SS using DOE-STD-3009 is applicable when the consequence to the facility worker is high. DOE-HNBK-1224 states "A prompt dose between 200 and 400 rad would cause serious injury (also a high consequence) and a prompt dose below 200 rad would not be a serious injury for a healthy worker." Doses at 120 rad over a 12 hour shift do not challenge a prompt dose of 200 rad and therefore result in worker doses significantly below the high FW consequence threshold.

9 Risk and Opportunities – Project Safety Decisions

This section describes risks and opportunities connected to major safety strategy decisions as they relate to the HLW Project. Consideration will be made for the potential impact of modifications to the original design that may occur as a result of a thorough assessment of the risks and opportunities presented herein. Subsequent steps through facility commissioning (CD-4) will be summarized including plans to coordinate resolution of identified risks and opportunities with project progress. The risks and opportunities listed below will be managed in accordance with 24590-WTP-GPP-PT-003, *Project Risk Management.*

The following list of risks is intended to identify those items most likely to have a major impact on the project safety control strategy or design approach. Exercising some or all of the opportunities may result in reduced exposures at the Analytical Laboratory in comparison to the original Project plan involving the Pretreatment Facility. This list is not intended to capture all open project risks and/or opportunities.

1. Proposed WAC parameters, which may change, were provided by the DFHLW integrated team in CCN 329144, *Updated Draft Direct Feed Waste Acceptance Criteria for Feed from Tank Farms*. The development of the DFHLW operational approach WAC is an ongoing effort that is addressing the optimization of an integrated Tank Farms/WTP waste treatment mission and will likely be revised as the optimization is finalized. The results of this effort will potentially impact the HLW Facility safety design strategy. To help inform the optimization of WAC parameters for safety basis use, and to allow continuation of the safety design basis, an engineering study was developed to evaluate the parameters affecting the safety design basis. The results of this evaluation are documented in 24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development*.

   Changes to the waste feed profile for material to be processed at the HLW Facility can impact the consequences and likelihood of analyzed design basis accidents in the facility. An increase in consequences could result in the necessity of additional hazard controls and affect the design of the facility. Conversely, decreases in hazardous materials could reduce consequences and reduce the number of necessary safety significant SSCs. A secondary safety design basis effect due to the changes in WAC parameters is associated with changes to facility equipment such as secondary offgas treatment systems. These changes could result in the necessity to increase the amount of hazardous chemicals needed for treatment such as Sodium Hydroxide or Ammonia Reagents. Early design modifications in response to reduction in consequences could also result in cost impacts to the project if reversal of these design modification is identified later in project life cycle, whereas early identification could result in project cost savings.

   This risk/opportunity will be closed upon finalization of the WAC SAC and implementation of any design changes associated with the revised WAC. The safety design basis risk can be minimized by evaluating a range of WAC parameters impacting the hazard control strategy, rather than basing the hazard evaluation and control strategy on a set value.

2. Delivery of waste from Tank Farms including the proposed vault facility is conceptual. Design details for these operations have the potential to require new or revise existing controls based on chemical constituents or fluid properties. To help inform the design of the waste feed approach, an engineering study was developed to evaluate the parameters affecting the HLW Facility safety design basis. The results of this evaluation are documented in 24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development*. Design/operational values for activities such as feed delivery are identified/evaluated in the engineering study. This includes specifying and justifying parameters for waste transfers external to the High-Level Waste (HLW) Facility, like pump pressure and transfer pipe design (e.g., diameter, wall thickness, etc.), that should

be within specified values to produce moderate or lower radiological and hazardous chemical dose consequences from spray release events. Impacts to the safety design basis can be limited by providing mechanical feed parameters to the DFHLW operational approach integrated team that limits consequences to receptors. This risk/opportunity can be closed upon receiving design parameter interfaces with the facility sending waste to the HLW Facility.

3. Changes to the glass formulation to account for changes to the waste feed to be received are not finalized. An opportunity exists to revise the glass formulations in conjunction with the changes in the WAC, yielding an overall improved product output in terms of safety, cost, and facility design. If these changes to glass formulation were to impact existing design or happen late in the design process this opportunity could incur unplanned costs and instead be classified as a risk. To protect the potential opportunity the facility design must accommodate the accumulated impacts of WAC and glass formulation on process factors, including their off-gas implications. Although overall it is anticipated that the change in glass formers is a net opportunity, the new glass formulation could have adverse impacts and/or risk that require further evaluation. Among these are impacts to melter feed rheology, hydrogen generation in melter feed and feed preparation vessels, increased NO_X concentrations in the melter offgas, and potential criticality safety implications. The increase in the likelihood of sulfate-layer explosions has been considered within the Hazards Analysis process and is considered bounded by existing controls. This conclusion has been reviewed, and concurrence obtained, by SDIT.

   The effects on the glass formulations will need to be evaluated and determined if there is an impact on the safety design basis. This risk/opportunity will be closed upon receiving the final glass formulation information from the DFHLW operational approach integration team and evaluated through the affected disciplines. This risk can be mitigated by qualitatively evaluating the proposed changes to the formulation.

4. Specific changes to UHGRs and their impact on consequences and controls are preliminary pending updates of design documentation. Changes to the waste feed parameters and glass formulations can impact the hydrogen generation rates within the melter feed preparation and feed vessels and associated control strategy. Lower UHGRs would increase the amount of time to reach flammable concentrations for both episodic and non-episodic releases of hydrogen. This in turn would provide additional time to implement hydrogen mitigation controls in an ashfall event, or the replacement of a failed agitator.

   This risk/opportunity will be closed upon finalization of the WAC and glass formulations, and evaluation of the impacts of the new parameters on UHGRs. This risk can be mitigated by evaluating a range of UHGRs as part of design. The lower value of UHGR proposed in the DFHLW Waste Acceptance Criteria, 24590-HLW-ES-TD-24-001, Rev 0 was evaluated in 24590-HLW-ES-NS-23-001, *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development.*

5. Final determination of changes to or addition of onsite support / utilities facilities is in process and finalization could impact interfaces or events in HA. These include, but are not limited to:

   - Total sample quantity/methodology
   - Definition of handling of wastewater and evaporator facility
   - Emergency Power technology, capabilities, and location
   - Standby Control room location and capabilities
   - Wet Chemical Receipt Facility material quantities and location.
   - Melter Fabrication and Replacement activities.

This risk/opportunity will be closed as design progresses and support systems are located and sized. This risk can be mitigated by early identification of potential hazards, or restrictions that are necessary to preclude a nuclear safety concern.

6. The safety strategy to address the revised ashfall criteria has yet to be fully implemented in the design. This strategy was defined in 24590-HLW-PDSA-NS-24-0001 Revision 0 but may require adjustment to be fully implementable both in engineered design and operational capabilities. This will continue to be monitored until the approval of a DSA for the HLW facility.

   Updating of the Code of Record to the latest standards could introduce unanticipated project scope expansion and resulting costs without a commensurate improvement in safety, reliability, or facility longevity. A cumulative rollup of the latest industry codes and standards into the Code of Record presents the unique opportunity of incorporating all of the industry lessons learned over the last few decades during which the WTP, and by extension HLW Facility project has been undertaken. Upgrading the COR to updated standards negates the risks and challenges of procuring new materials under obsolete standards, an activity typically associated with an accompanied high cost.

   Conflicts between the revised codes and standards and the existing COR for as-procured and as-built SSCs will be resolved using a process defined in DOE-STD-1189-2016, Section 5.4 and Appendix G. This process accepts as-built SSCs within the new standard by using technical justifications except in those instances in which an upgrade is required by the design bases in order to achieve a revised performance target.

7. A criticality control strategy for Heavy Plutonium Particulates (HPP) may have risks to the cost and schedule of the facility but is still to be determined based on future evaluations of the new feed to be delivered to the HLW Facility and the associated changes in process and operating conditions. Potential controls may require implementation of a new standard such as ANSI/ANS-8.14, and compliance with it would have increased costs like administrative controls for operations personnel to implement along with associated training and qualification of facility personnel to operate and implement the criticality control strategy for HPP. Although not anticipated, if evaluations show that a criticality accident with HPP is credible, then consideration for a Criticality Accident Alarm System would be required. In addition, evaluations of HPP could result in needing new interface controls or constraints on the WAC for the feed to be delivered to the HLW Facility.

   This risk will be closed as the feed profile is finalized and it is determined if additional testing or capabilities are required.

8. Seismic / Safety Classification Risk – Reclassification of legacy Safety Class and SC-I controls to Safety Significant and SC-III has been performed based on preliminary DFHLW operational approach feed information. Pending finalization of design inputs and completion of hazards analysis, these decisions are performed at risk. Finalization of design of reclassified controls reduces design complexity and allows for controls to be designed, procured, and installed commensurate with the magnitude of hazards associated with HLW Facility operations.

9. Chemical Safety Approach Opportunity - Opportunities for control simplification may be realized dependent on constituents of the secondary offgas. If secondary offgas is determined to pose a chemical only hazard controls can be developed using governing chemical safety standards and simplified from existing nuclear safety control set. A chemical safety management program that is similar to those used by high-performing chemical industry peers will be developed to manage and control chemical hazards associated with the nuclear facility operations.

10. PPJ Simplification Opportunity - Based on lessons learned from implementation of the LAW facility PPJ control system, an opportunity exists for HLW PPJ control system simplification. Specifically, a reduction in the required number of said controls based on reduced consequences of hazards analysis events is being considered. Redundancy will be evaluated based on the impact to facility operations,

namely maintenance related outages and/or increases in the frequency of control system proof testing. To ensure a robust control strategy the re-evaluation required to simplify the PPJ control system will be based on the principles of control hierarchy, such as credited passive primary confinement and credited active secondary confinement.

11. Requirement Deviations – Changes to DOE directives, contract direction, or other governing codes and standards can affect the design of facilities and systems associated with the HLW Project mission and adversely impact the schedule to complete the activities. Any deviations can also impact construction, commissioning, and future operations associated with the mission and the schedule to complete the associated activities.

12. The Analytical Laboratory is a common use facility that is designed to simultaneously service both DFLAW (presently) and DFHLW (planned). There exists a risk that if the design basis and Code of Record for DFLAW, DFHLW, and the Lab facility are not properly managed a conflict could arise that would adversely impact DFLAW operations. Presently the specific design codes and standards to be used for the design of the safety SSCs between the LAW, HLW and Lab facilities are identified in the following documents:

    - 24590-WTP-COR-MGT-15-00001, *Engineering, Procurement, and Construction (EPC) Code of Record*
    - 24590-WTP-COR-MGT-18-00001, *Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities*

    The Code of Record(s) will be modified using a graded approach to support the common use of the Lab Facility during DFLAW/DFHLW operations and will ensure that at all times the Lab Facility remains fully qualified to support ongoing DFLAW operations. The final version of the COR for each facility will bound all modes of operations with the scope of the Lab Facility. A focus will be made on the design and safety features of interfacing SSCs to further aid in the graded approach.

13. As a result of revised DFHLW operational approach feed properties, the HLW Facility dose rates are anticipated to be lower than previously evaluated in design. This presents a Project wide opportunity to reconcile the shielding requirements necessary to properly control worker radiation dose while meeting the requirements of both 10 CFR Part 830 and 10 CFR Part 835.

    There exists a mission opportunity to utilize the existing Analytical Laboratory (Lab) facility to service the intermediary "Vault" facility. This mission opportunity would impose a project risk on the Analytical Laboratory facility to ensure that the additional samples were evaluated to preclude inadvertent nuclear criticality, mitigate radiological and chemical hazards, and have sufficient capabilities to properly characterize the physical characteristics of the waste material (density, viscosity, and yield stresses), as well as address potentials for hydrogen release. The current design is bounded by the HLW WAC SAC limitations, while the original facility design was for PTF feed and reasonable margin exists, evaluations would have to be completed to implement this in the safety basis.

14. There are opportunities to allow DFHLW to tune its WAC too accept more fissile material into the facility. Current data from tank farms received by WTP includes margin to account for uncertainty, however, as sampling becomes more accurate and knowledge of the feed increases additional opportunities to definitize the control strategy exist. These opportunities could allow for the CSER to reduce conservatisms due to the uncertainties presented WTP with the radionuclide concentrations. This subsequently would allow for higher amounts of fissile material to be loaded into the glass canisters thus accelerating the Hanford mission.

15. Temporary safety equipment (including ashfall equipment) should be reviewed to ensure appropriate pedigree during procurement. Due to opportunities for redundant backup equipment and the portable

nature of these SSCs procurement at a "Q" level may or may not provide additional value to the safety significant attributes. This should be evaluated as part of the procurement formation process.

16. Multiple lessons were learned in the implementation of the CSMP during cold commissioning of DFLAW. Those lessons learned provide opportunities for improvement of the CSMP application, screening of SIH, and the application of PSM.

17. Application of DOE-STD-1066-97 may have unintentional impacts on delivered equipment. 24590-WTP-COR-MGT-18-00001, *Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities,* Rev 3, calls out a DOE-STD-1066-97. Delivered crane fire suppression systems built under this standard use a now known toxic, corrosive chemical, that produces PFAS. Also, procurement of replacement components of this obsolete system is now extremely difficult. A revised approach to fire protection for areas which previously required crane mounted fire protection systems should be considered.

18. Open questions from external oversight exist on the project's application of ARCON96 for dispersion analysis as identified in this document. These open concerns could result in rework if resolution requires any re-analysis or change in methodology which impact results.

10 Safety Analysis Approach and Plan

10.1 Safety Analysis Process

DOE and BNI agreed to utilize DOE-STD-1189-2016, *Integration of Safety into the Design Process* and DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis* for the HLW Facility. For the Analytical Laboratory it is anticipated that as a HC-3 facility that DOE-STD-1228-2019 *Preparation of Documented Safety Analysis for Hazard Category 3 Nuclear Facilities* will be utilized.

The safety analysis approach for both facilities include the hazard identification, categorization, and evaluation process. The hazard identification process will develop a bounding inventory for radiological and non-radiological hazards. Given the bounding radiological inventory, final categorization of the facility will be in accordance with DOE-STD-1027-92, Change 1.

The accident analysis includes a quantitative evaluation of limiting accident consequences to aid in the selection and functional classification of controls. Accident consequences will be evaluated against DOE thresholds/risk acceptance criteria. The methodology evaluates process-related hazards, NPH, and external man-made hazards that could affect the public, CLW, FW, or the environment, which is based on the graded approach as described in 10 CFR 830.7.

As the design progresses, both hazards analysis will be revised and validated against the design to reflect process level hazards. Hazard analysis outputs will include credible hazard scenarios applicable to the HLW and Lab Facility including consequence assessments and likelihood of occurrence. The qualitative assessment for each scenario will identify a primary preventive and/or mitigative control that stops the accident progression. Secondary controls that could provide additional protection are also listed (defense in-depth).

Administrative controls credited in the accident analysis for preventing or mitigating a DBA/EBA are also functionally classified if the safety function rises to the level of SC or SS. An SC or SS administrative control is designated a SAC in accordance with DOE-STD-1186 and will be protected via TSRs. Preliminary functional classification of controls is performed to support the design effort. Throughout the hazards analysis process, feedback will be provided to the design through the SDIT Team. When the design is made final, the comprehensive hazards analysis will be finalized and placed under configuration control and the accident analysis will be completed.

Safety analyses calculations are also used to support the HA and accident analysis processes for safety design basis development. This includes the evaluation of analyzed accident conditions (from bounding and unique accidents) that result in the release of radioactive and/or chemically hazardous materials and the subsequent consequences to the CLW and public.

The HLW Facility currently has an approved existing PDSA (24590-HLW-PDSA-NS-24-0001), which documents the above information, and will be further developed and revised as design progresses to ensure safety is integrated into the design. The PDSA is appropriately updated as the design changes so that procurement and construction activities may proceed, thereby achieving design completion with a configuration managed safety design basis. PDSA changes requiring DOE approval shall receive approval prior to procurement, and construction associated with the changes. The Lab Facility as a less than HC-3 nuclear facility operates under a Hazard Analysis Report to support DFLAW operations (24590-LAB-HAR-NS-18-0001) and has an approved PDSA (24590-WTP-PSAR-ESH-01-002-06) to support construction authorization. Both documents are anticipated to be superseded by a new PDSA and the facility promoted to an HC-3 nuclear facility. The development of a PDSA will occur using the "safe harbor" methodology of DOE-STD-1228-2019. This PDSA will supersede the existing Lab HAR but will be introduced so as to not interrupt DFLAW operations.

An HLW Facility DSA (which supersedes the PDSA) will be developed per 10 CFR 830.204, *Nuclear Safety Management*, and submitted to DOE for approval no less than six (6) months prior to the need for DOE approval to support commissioning. TSRs will also be developed per 10 CFR 830.205, *Nuclear Safety Management*. A Lab Facility DSA will also be developed per 10 CFR 830.204 but will be submitted for DOE approval once deliberate transition is ensured so as to not interrupt existing DFLAW operations. The DSA for the Lab Facility will bound both DFHLW and DFLAW operations.

10.2 Safety Project Deliverables

The HLW Facility PDSA (24590-HLW-PDSA-NS-24-0001) and supporting hazard analysis will be revised to implement DOE-STD-3009-2014 as the safe harbor methodology. The Lab Facility PDSA (24590-WTP-PSAR-ESH-01-002-06, Rev 5c *Preliminary Documented Safety Analysis to Support Construction Authorization; Lab Facility Specific Information*) and supporting hazard analysis will be revised to implement DOE-STD-1228-2019 as the safe harbor methodology. The revised PDSAs will include preliminary TSRs to inform the final safety approach and design. The PDSA, SDS and other project safety documents (e.g., Criticality Safety Evaluation Reports, Preliminary Fire Hazard Analysis, whenever applicable) will be updated to maintain alignment with the design as it evolves throughout the life of the project. As system PrHA development is dependent on the design completion of each system, hazard evaluation will go through iterations as design matures and completes. Accordingly, the PDSA will be updated to reflect the design and results of the hazard analysis. If necessary, these updates will inform an update to the SDS. It is anticipated that design for the HLW Facility and support facilities will be finalized by the end of 2027. The major safety project deliverables to support design completion are included in Table 8, and safety design basis milestone chart is provided in Appendix B.

Table 8 Major Project Safety Deliverables

Safety Basis Deliverable	Description
DOE-STD-1189-2016 IP	The Implementation Plan will provide the scope, approach, and schedule for implementation of DOE-STD-1189-2016.
HLW and Lab PDSA Revisions	The revisions incorporate updated consequence analysis results based on assumed DFHLW operational approach feed properties, hazard controls result from updated hazard analyses, design updates and considerations and updates necessary for the implementation of DOE-STD-1189 2016, DOE-STD-3009-2014 (HLW Facility), and DOE-STD-1228-2019 (Lab Facility).
HLW and Lab Hazard Categorization Calculations	HLW and Lab Facility hazard category calculations will be revised to reflect the revised DFHLW operational approach feed profile for HLW.
HLW and Lab Criticality Safety Evaluations and Determinations	HLW Facility CSER and Lab criticality safety determination will be revised to reflect the revised DFHLW operational approach feed profile.
HLW and Lab Consequence Calculations	The facility consequence analysis calculations will be revised to reflect the revised DFHLW operational approach feed profile, the feed delivery configuration, and to update and modify assumptions to remove any overly conservative assumptions.
HLW and Lab PrHAs	These PrHAs will be revised to reflect the updated consequence assumptions, revised DFHLW operational approach feed profile for HLW, and feed delivery configuration.
HLW Preliminary Fire Hazards Analysis (PFHA) and Lab Fire Hazards Analysis (FHA) Revisions	The existing PFHA and FHA will be updated based on the revised DFHLW operational approach feed profile and for consistency with the PDSA and facility design.

Safety Basis Deliverable	Description
Safety Basis Program Documents	Safety basis program documents will be revised to incorporate the approaches in both standards and incorporate lessons learned from DFLAW.
Criticality Safety Program Documents	Criticality safety program documents will be revised to incorporate the DOE O 420.1C, Change 3 requirement and lessons learned from DFLAW.
Chemical Safety Management Program	Chemical management program based on 10 CFR Part 851, *Worker Safety and Health Program*

10.3 Approach for Developing Project Safety Basis Documentation

The process described in DOE-STD-1189-2016 for development of the preliminary documented safety analysis report concludes at the completion of the design phase and submittal of the PDSA to DOE for review and approval to support construction. The HLW Facility currently has a DOE-approved PDSA that supports procurement and construction of the HLW Facility. The existing PDSA (24590-HLW-PDSA-NS-24-0001) was developed following earlier standards and approaches and will be updated to be compliant with DOE-STD-3009-2014. The PDSA and CSMP (see section 3.7.5) will govern activities during HLW Facility construction, procurement, start up, and cold commissioning. The PDSA and SDS will be maintained as described in section 10.6 to allow continued procurement and construction of the HLW Facility. The PDSA will be graded as appropriate for the project phase in accordance with DOE-STD-1189. The Analytical Laboratory currently has a DOE-approved PDSA that supports completion of design, commissioning, and operation of the Lab Facility as a HC-3 facility and a Hazards Analysis Report that supports operations of the Lab Facility as a less than HC-3 facility. The existing PDSA (24590-WTP-PSAR-ESH-01-002-06) will be updated to follow the safe harbor methodology of DOE-STD-1228-2019. When the requirements for DOE-STD-3009-2014/DOE-STD-1228-2019 and DOE-STD-1189-2016 are implemented, the HLW PDSA will be renumbered and issued as 24590-HLW-PDSA-NS-24-0001 Revision 0 and the LAB PDSA will be renumbered and issued as 24590-LAB-PDSA-NS-25-0001 Revision 0.

Following DOE-STD-1189-2016, preliminary TSRs will be developed in parallel with and included within revisions to the PDSA. The preliminary TSRs will be prepared on a schedule jointly developed between WTP and DOE that reflects maturation of the HLW Facility design and further development of the PDSA. The preliminary TSRs should be available to support cold commissioning of the HLW Facility.

The formal TSRs will be developed and submitted to DOE for approval along with the documented safety analysis.

The preparation of the DSAs will begin at the completion of design and will comply with standards DOE-STD-3009-2014 (HLW Facility) and DOE-STD-1228-2019 (Lab). The DSAs will be developed on a schedule developed jointly between WTP and DOE. The schedule will allow sufficient time for DOE review and approval followed by HLW Facility implementation in advance of operations (i.e., hot commissioning) as well as approval of the classification of Lab as an HC-3 facility. The DSAs and TSRs will then be implemented prior to commencement of hot commissioning.

10.4 TSR Development

Preliminary HLW Facility TSRs are planned for inclusion in Chapter 5 of 24590-HLW-PDSA-NS-24-0001 Revision 0 to accompany full alignment with DOE-STD-1189-2016. The preliminary TSRs are intended to support design completion to ensure the facility design can accommodate the proposed TSR approach. Full TSR development will be completed in FY30 and the initial DSA and TSR document will be issued to support commissioning activities.

10.5 Critical Decision Matrix

In 2003, under CCN 057394, ORP to BNI, *Approval of Critical Decision (CD) 2, Performance Baseline, and CD 3C, Full Construction Authorization, for the Hanford Waste Treatment and Immobilization Plant (WTP)*, 03-AMWTP-031, the DOE approved a Performance Baseline of CD 2 and authorized full construction of the WTP site (CD-3c). The wholesale designation was applied to the WTP site and approval was contingent on full construction and integrated water testing, however no distinction was made uniquely for specific WTP facility buildings (DFLAW, HLW Facility, Lab) etc.

The criteria for Critical Decisions found in Appendix A of DOE-STD-1189-2016, *Integration of Safety into the Design Process* is further applied above and beyond the original authorization solely for the sake of assessing existing HLW Project status. This approach should not be considered legally binding nor superseding of the original construction approval obtained in CCN 057394 and should be considered primarily a project management process tool. The CDs discussed in DOE-STD-1189-2016 are executed in accordance with DOE Order 413.3B *Program and Project Management for the Acquisition of Capital Assets.*

10.6 Change Control

The objective of change control is to maintain alignment among design requirements, the physical configuration, and the related safety design basis documentation as changes are made. The HLW Facility safety design basis including the PDSA (24590-HLW-PDSA-NS-24-0001) will implement a safety basis change control process for safety documentation consistent with Section 3.8.3 of DOE-STD-1189-2016.

As design matures, changes to the design, hazards, and resulting safety controls are discussed in regularly scheduled SDIT meetings and are communicated to the CIPT via communication from the SDIT. Once the design is captured in the PDSA, it is submitted to ORP for review. Changes that have the potential to impact safety in design will need to be controlled to ensure the proposed HLW Facility scope and design remain in a configuration that is bounded by the configuration analyzed in the PDSA.

The integrity of the PDSA configuration baseline for HLW and Lab is protected by a PDSA change control process as mandated by Section C, Standard 9 of the WTP contract and documented in 24590-WTP-3DP-G040-00022, *Licensing Information*. This process relies on the five criteria given in Section 3.8.3 of DOE-STD-1189-2016 to determine if a PDSA revision is necessary due to post-PDSA approved design changes. This Safety Evaluation Process evaluates design changes based on their potential impact on hazards, accident analyses, and structures, systems, and components (SSCs) as defined in the PDSAs. It also determines whether a change to the PDSA is required and if DOE approval is necessary. Presently, the PDSAs are maintained by following 24590-WTP-GPP-RANS-NS-0002, Safety Evaluation Process for DOE Approved Preliminary Documented Safety Analysis. The Safety Evaluation Process has been updated to include consideration of the SDS and the safety in design approach.

10.7 Safety Analysis Software

Safety analysis tools that are used to perform safety analysis for the HLW Facility include software for atmospheric dispersion, direct radiation hazards, and in support of criticality evaluations.

Atmospheric dispersion factors (χ/Qs) for the public will be developed using MACCS2 per "Option 3" of the DOE-STD-3009-2014 (Section 3.2.4.2), and recent meteorological data obtained from Hanford Weather Station (HWS). For events concerning radiological and hazardous chemical releases, the HLW Facility may use a χ/Q for CLW that is developed based on the Facility and/or WTP site characteristics using ARCON96 as warranted per DOE-STD-3009-2014, Section 3.2.4.2 and 3.2.4.3. An atmospheric dispersion modeling protocol (24590-HLW-RPT-NS-23-001, *Atmospheric Dispersion Modeling Using*

ARCON96 for Co-located Worker (CLW), approved by DOE-ORP in CCN 336729, 23-NSD-0042) is proposed for implementation.

Direct radiation dose rates and shielding analysis will be performed using MicroShield® when analyzing solid shielding (limited to photon radiation), Monte Carlo N-Particle (MCNP®) for analyzing complex shielding scenarios, and Attila® for analyzing complex scenarios where convergence may be difficult to achieve with MCNP.

Criticality safety calculations that support criticality evaluations will be produced with MCNP & Whisper software. The version of the software that is approved for use at the time of the calculations will be utilized.

To use software to produce and issue calculations that provide a basis for the safety design basis and future safety basis, documentation that demonstrates application of software quality and quality assurance requirements must first be approved. As noted in Section 3.4.2, for the HLW Facility going forward, there will be a transition to DOE O 414.1D Chg 2, *Quality Assurance*. The software requirements in DOE O 414.1D will be contained in upper tier requirements documents and flowed down through program documents and procedures that guide the work products.

11 Safety Design Integration Team (SDIT) – Interfaces and Integration

The Safety Design and Integration Team (SDIT) is an important component of the safety and design integration effort as defined in DOE-STD-1189-2016, *Integration of Safety into the Design Process*. The SDIT ensures effective coordination among design functions, traditional worker safety disciplines, and emergency management to develop a design compliant with the project requirements while achieving the overall safety strategy.

The SDIT is responsible for overseeing the preparation and implementation of the SDS, performing a thorough risk and opportunity assessment, and overseeing the development of the PDSAs, DSAs, and TSRs as they relate to the DFHLW Project (including the HLW Facility and the Analytical Laboratory). As the Lab Facility is constructed and in operation, minor changes to the facility will not occur under SDIT review unless the change could significantly impact the DFHLW Project. For example, changes that have been identified to result in a change to the feed would require SDIT review and subsequent referral to the IPT/CIPT teams.

The primary functions of the SDIT include:

- Supporting the Integrated Project Team (IPT)/Contractor Integrated Project Team (CIPT) to ensure safety is integrated into the design process
- Identifying and analyzing potential hazards within the facility
- Ensuring the selected controls are sufficient to perform their intended safety functions
- Addressing the requirements of project interfaces, such as safeguards and security needs (DOE O 470 series)
- Ensuring selected controls align with the control selection hierarchy and represent cost-effective solutions to safety challenges

The SDIT is a typically comprised of a subset of the CIPT, plus other specialties as needed, and interfaces with several departments, including design authority, nuclear safety, chemical safety, operations, and maintenance. These teams comprise supplemental SMEs in a range of disciplines who are collectively capable of assessing the design development process, understanding safety-in-design requirements, and assessing the risks, opportunities, and uncertainties associated with important project decisions.

As the contractor responsible for this project a CIPT will be established to accomplish the assigned responsibilities. The Project Manager will serve as the team leader, and the Safety Lead serves as a team member. CIPT members should possess relevant competencies for the project, including systems engineering.

The CIPT's responsibilities include:

- Ensuring that safety is effectively integrated into the design and construction processes in a timely manner
- Monitoring the performance of safety and design tasks and deliverables to ensure that they are integrated and in sync
- Informing the IPT of any challenges related to the integration of safety and design tasks that may impede successful completion of the project

The CIPT maintains close coordination with the SDIT, which is involved in the safety analysis, design, construction, and operational planning details. The SDIT is the ultimate source of project information related to safety-in-design activities, and its assigned responsibilities parallel those of the IPT. The CIPT assists the IPT in resolving design issues. The IPT is a joint contractor and DOE oversight group that operates parallel to the CIPT. Prior to the establishment of the CIPT, the contractor established an HLW "Firm the Foundation Team", (HFFT) and its steering committee continue to operate after the establishment of the CIPT and IPT.

The SDIT must closely interface with various project and discipline interfaces to ensure the integration of safety into the project design. Key project and discipline interfaces include the radiological, structural, and process engineering all of which require close integration to ensure radiological shielding requirements and chemical / radiological effluents are properly managed and compatible with the overall HLW Facility design.

The SDIT interfaces with the CIPT and the (Federal) Integrated Project Team (IPT) to ensure the integration of safety into the project design.

12 References

12.1 Project Documents

12.1. 24590-HLW-3DG-W10W-00001, Rev 0, *HLW Nuclear Safety Analysis Design Guide*

12.2. 24590-HLW-ES-ENG-22-004-01 *Code of Record Evaluation – HLW Firm the Foundation Volume 1 – Introduction*

12.3. 24590-HLW-ES-ENG-22-004-02 *Code of Record Evaluation – HLW Firm the Foundation Volume 2 – Laws and Regulations, and Permits*

12.4. 24590-HLW-ES-ENG-22-004-03 *Code of Record Evaluation – HLW Firm the Foundation Volume 3 – Mechanical Systems and Handling*

12.5. 24590-HLW-ES-ENG-22-004-04 *Code of Record Evaluation – HLW Firm the Foundation Volume 4 – Civil Structural and Architectural*

12.6. 24590-HLW-ES-ENG-22-004-05 *Code of Record Evaluation – HLW Firm the Foundation Volume 5 - HVAC*

12.7. 24590-HLW-ES-ENG-22-004-06 *Code of Record Evaluation – HLW Firm the Foundation Volume 6 – Controls and Instrumentation*

12.8. 24590-HLW-ES-ENG-22-004-07 *Code of Record Evaluation – HLW Firm the Foundation Volume 7 - Electrical*

12.9. 24590-HLW-ES-ENG-22-004-08 *Code of Record Evaluation – HLW Firm the Foundation Volume 8 – Nuclear Safety Engineering*

12.10. 24590-HLW-ES-ENG-22-004-09 *Code of Record Evaluation – HLW Firm the Foundation Volume 9 – NSE, RAD, PM, SE*

12.11. 24590-HLW-ES-ENG-22-004-10 *Code of Record Evaluation – HLW Firm the Foundation Volume 10 – Fire Protection*

12.12. 24590-HLW-ES-ENG-22-004-11 *Code of Record Evaluation – HLW Firm the Foundation Volume 11 – DOE Orders/Standards*

12.13. 24590-HLW-ES-ENG-23-002-02 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 02 – Fire Protection*

12.14. 24590-HLW-ES-ENG-23-002-03 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 03 – Mechanical Systems*

12.15. 24590-HLW-ES-ENG-23-002-04 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 04 – C&I*

12.16. 24590-HLW-ES-ENG-23-002-05 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 05 – Electrical*

12.17. 24590-HLW-ES-ENG-23-002-06 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 06 – Civil, Structural, and Architectural*

12.18. 24590-HLW-ES-ENG-23-002-07 *Code Tailoring Evaluation – HLW Firm the Foundation Volume 07 – HVAC*

12.19. 24590-HLW-ES-NS-20-001, Rev 6, *Hazard Analysis for Preliminary Documented Safety Analysis of High Level Waste Facility*

12.20. 24590-HLW-ES-NS-22-001, Rev 0, *High-Level Waste Facility Consequence Calculation Updated Feed and Design Impact Study*

12.21. 24590-HLW-ES-NS-23-001, Rev 2 *Formal Engineering Study Associated with Nuclear Safety Waste Acceptance Criteria Development*

12.22. 24590-HLW-PL-MGT-22-001, Rev 2, *HFFT Lessons Learned Implementation Plan*

12.23. 24590-HLW-RPT-ESH-01-001, Rev 9, *Preliminary Fire Hazards Analysis for the High-Level Waste Building*
12.24. 24590-HLW-TB-MGT-23-0007, Rev 0, *HFFT Decision – Workstream 2.4 Code of Record Team, Seismic*
12.25. 24590-HLW-Z0C-U10T-00001, Rev 0, *Initial Hazard Categorization for HLW*
12.26. 24590-LAB-HAR-NS-18-0001, Rev 2, *Analytical Laboratory Hazard Analysis Report to Support DFLAW Operations*
12.27. Deleted
12.28. 24590-WTP-3DI-W12W-00002, Rev 0, *Application of ALARA in the Design Process*
12.29. 24590-WTP-3DI-W12W-00004, Rev 2, *Classification of Areas for Design*
12.30. 24590-HLW-3DP-G03B-00001, Rev 0, *HLW Design Process*
12.31. 24590-WTP-3DP-G040-00022, Rev 10, *Licensing Information*
12.32. 24590-WTP-COR-MGT-18-00001, Rev 3, *Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities*
12.33. 24590-WTP-CSER-ENS-08-0001, Rev 1A, *Preliminary Co-Precipitated Plutonium Criticality Safety Evaluation Report for the WTP Project*
12.34. 24590-WTP-DB-ENG-18-001, Rev 4, *Basis of Design for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities*
12.35. 24590-WTP-DC-ENG-19-001, Rev 0, *Shielding Design Criteria for WTP Offset and Straight Through Penetrations, Shadow Shields, and Embedded Pipes/Conduits and Radioactive Process Piping*
12.36. 24590-WTP-G63-RAWS-WS-0001, Rev 2, *Hanford Tank Waste Treatment and Immobilization Plant Worker Safety and Health Policy*
12.37. Deleted
12.38. Deleted
12.39. Deleted
12.40. 24590-WTP-GPP-RANS-NS-0002, Rev 7, *Safety Evaluation Process for DOE Approved Preliminary Documented Safety Analysis*
12.41. 24590-WTP-GPP-RANC-SS-0002, Rev 0, *Worker Safety through Design*
12.42. 24590-WTP-PD-RACS-CS-0002, Rev 2, *Criticality Safety Program*
12.43. 24590-WTP-PD-RADA-RE-0001, Rev 2, *Radiological Engineering and ALARA for Design*
12.44. 24590-WTP-PD-RAIT-SQ-0001, Rev 7, *WTP Software Quality Program Description*
12.45. 24590-WTP-PD-RAQA-QA-0001, Rev 4, *Quality Assurance Program Description*
12.46. 24590-WTP-PD-RAQA-QA-0002, Rev 1, *WTP Graded Approach*
12.47. 24590-WTP-PD-RANC-SS-0002, Rev 0, *Worker Safety through Design Program Description*
12.48. 24590-WTP-PD-RAWS-WS-0002, Rev 4, *Worker Safety and Health Requirement Area - Worker Safety Program Description*
12.49. 24590-WTP-PL-NS-01-002, Rev 7, *RPP-WTP Occupational ALARA Program for Design*
12.50. 24590-HLW-PDSA-NS-24-0001, Rev 0, *Preliminary Documented Safety Analysis for the High-Level Waste Facility*
12.51. Deleted
12.52. 24590-WTP-PSAR-ESH-01-002-06, Rev 5C *Preliminary Documented Safety Analysis to Support Construction Authorization; Lab Facility Specific Information*
12.53. 24590-WTP-QAM-QA-06-001, Rev 22, *DFLAW Engineering, Procurement, and Construction Quality Assurance Manual*
12.54. 24590-WTP-QIP-RAQA-QA-0002, Rev 4, *Engineering, Procurement, and Construction Quality Assurance Implementation Plan*

12.55. 24590-WTP-QIP-RAQA-QA-1001, Rev 2, *Commissioning and Operations Quality Assurance Implementation Plan, Volume 1*

12.56. 24590-WTP-QIP-RAQA-QA-1002, Rev 3, *Commissioning and Operations Quality Assurance Implementation Plan, Volume 2*

12.57. 24590-WTP-REQM-RARP-RP-0001, Rev 1, *Waste Treatment Plant Construction and Commissioning Radiological Control Manual*

12.58. 24590-WTP-RPP-ESH-01-001, Rev 5, *Radiation Protection Program for Design, Construction, Commissioning and Operations*

12.59. 24590-WTP-RPT-ENS-10-001, Rev 3, *WTP Methodology for Spray Leak Scenarios*

12.60. 24590-WTP-RPT-ENS-12-008, Rev 0, *Selection of the ARCON96 Computer Program to Generate Atmospheric Dispersion Factors for the WTP Co-Located Worker.*

12.61. 24590-WTP-RPT-ENS-13-004, Rev 1, *ALARA Optimization Report*

12.62. 24590-WTP-RPT-ENS-13-020, Rev 0, *WTP Methodology for Liquid Spill Scenarios*

12.63. 24590-WTP-SRD-ESH-18-001-01, Rev 3, *Safety Requirements Document for the High-Level Waste (HLW) Facility*

12.64. Deleted

12.65. Deleted

12.66. Deleted

12.67. Deleted

12.68. 24590-WTP-WSHP-ESH-18-00001, Rev 5, *WTP Worker Safety and Health Program*

12.69. 24590-WTP-Z0C-W14T-00003, Rev 2, *Meteorological Data Preparation*

12.70. 24590-WTP-Z0C-W14T-00022, Rev 7, *Atmospheric Dispersion Factors at the Public Boundary*

12.71. 24590-WTP-Z0C-W14T-00027, Rev 2, *Co-Located Worker Atmospheric Dispersion Factors Using ARCON96*

12.72. 24590-WTP-Z0C-W14T-00028, Rev 1, *Minimum Distances to the Public Boundary*

12.73. CCN 023036, BNI to ORP, *Contract No. DE-AC27-01RV14136 – Hanford Waste Tank Treatment and Immobilization Plant Purchase Order 24590-CM-MRA-MWD0-00003*, dated April 16, 2002

12.74. CCN 031977, ORP to BNI, *Bechtel National Inc. (BNI) Request for Authorization to Commence Construction Activities for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Prior to Preliminary Safety Analysis Report 10 Code of Federal Regulations (CFR) 830.206*, 02-AMPD-034, dated April 11, 2002

12.75. CCN 038711, ORP to BNI, *Bechtel National, Inc. (BNI) Request for Authorization to Commence Construction Activities for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) Prior to Preliminary Safety Analysis Report (PSAR) Approval per 10 Code of Federal Regulations*, 02-AMPD-0106, dated August 7, 2002

12.76. CCN 057394, ORP to BNI, *Approval of Critical Decision (CD) 2, Performance Baseline, and CD 3C, Full Construction Authorization, for the Hanford Waste Treatment and Immobilization Plant (WTP)*, 03-AMWTP-031, dated April 25, 2003.

12.77. CCN 254371, *Direction for Co-Located Worker Atmospheric Dispersion Coefficient (χ/Q) Used Safety Analysis Consequence Calculations*

12.78. CCN 268860, *Reissue of Updated Safety Analysis Direction*

12.79. CCN 274194, *Response to Request for Clarification of the U.S. Department of Energy, Office of River Protection Direction Related to Atmospheric Dispersion as Given in Letter 14-NSD-0016, Reissue*

12.80. CCN 281177, ORP to BNI, *Updated Safety Analysis Direction*, 15-NSD-0017, dated June 29, 2015

12.81. CCN 286883, ORP to BNI, *Waste Treatment and Immobilization Plant Analytical Laboratory Path Forward for Development of the Facility Documented Safety Analysis and Conduct of a Startup Readiness Review*, dated January 21, 2016
12.82. CCN 315305, ORP to BNI, *Approval of 24590-LAB-HAR-NS-18-0001, Rev. 0, Analytical Laboratory Hazard Analysis Report to Support Direct Feed Low-Activity Waste Operations*, dated July 3, 2019
12.83. CCN 330976, ORP to BNI, *Results and Next Steps from the High-Level Waste Facility Scoping Workshop*, 22-WTP-002889, dated October 3, 2022
12.84. CCN 333626, *Updated: Implementation Guidance for Chemical Safety Management*, DOE Memorandum (DOE/Mikolanis memo), 07/23/2020, Michael A. Mikolanis
12.85. CCN 336729, ORP to BNI, *Approval of Document 24590-WTP-PSAR-ESH-01-002-04, Preliminary Documented Safety Analysis to Support Construction Authorization, Rev.12*, dated December 19, 2023
12.86. Deleted
12.87. Deleted
12.88. 24590-WTP-COR-MGT-15-00001, Rev 3, *Engineering, Procurement, and Construction (EPC) Code of Record*
12.89. 24590-WTP-GPP-RACW-CH-0002, Rev 3, *Chemical Management Process*
12.90. 24590-LAB-U4C-60-00003, Rev 1*, Hazard Categorization for the Analytical Laboratory for DFLAW Only Operations*
12.91. 24590-HLW-QAM-RAQA-QA-0001*, HLW Quality Assurance Manual*
12.92. 24590-HLW-PD-RAQA-QA-0002, Rev 1, *HLW Graded Approach*
12.93. 24590-LAB-SQAP-RAQA-LQ-0001, Rev 1, *Analytical Laboratory Supplemental Quality Assurance Plan*
12.94. 24590-HLW-ES-TD-24-001, Rev 0, *DFHLW Configuration Optimized WAC Formal Engineering Study*

12.2 Other Documents

12.95. DOE. 2000. DOE Contract DE-AC27-01RV14136, *Hanford Tank Waste Treatment and Immobilization Plant*, as amended. US Department of Energy, Richland Operations Office, Richland, WA.
12.96. HNF-SD-GN-ER-501, *Natural Phenomena Hazards*, Hanford site, Washington
12.97. International Commission on Radiological Protection Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*
12.98. International Commission on Radiological Protection Publication 72, *Age-dependent Doses to Members of the Public from Intake of Radionuclides*
12.99. NRC Regulatory Guide 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants Rev. 1,* 02/1983, US Nuclear Regulatory Commission, Washington, D.C.

12.3 Codes and Standards

Complete reference information for codes tailored in Appendix C is included in the Code of Record or SRD and is not repeated here.

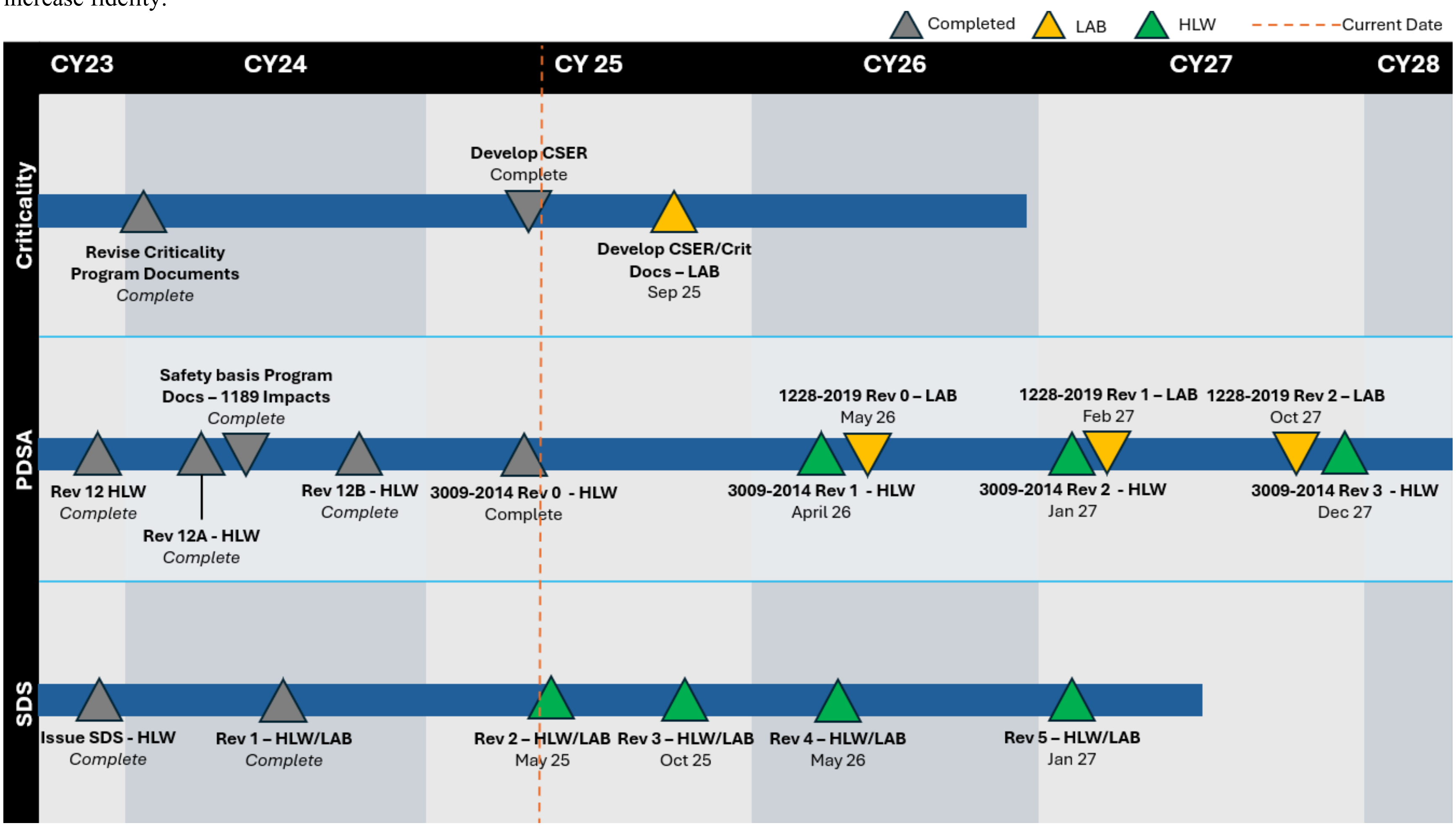
12.100. DOE G 413.3-1, *Managing Design and Construction Using Systems Engineering for Use with DOE O 413.3A*
12.101. DOE G 413.3-7A, *Risk Management Guide*
12.102. DOE G 413.3-18A, *Integrated Project Team: Guide for Formation and Implementation*
12.103. DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*
12.104. DOE O 414.1C&1D, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.
12.105. DOE O 420.1C, Change 3, *Facility Safety*, U.S. Department of Energy, Washington, D.C.
12.106. DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C, Facility Safety*
12.107. DOE-STD-1020-1994, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, U.S. Department of Energy, Washington, D.C.
12.108. DOE-STD-1020-2016, *Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities*, U.S. Department of Energy, Washington, D.C.
12.109. DOE-STD-1027-92, Change 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.
12.110. DOE-STD-1066-1997, *Fire Protection*, U.S. Department of Energy, Washington, D.C.
12.111. DOE-STD-1073-2016, *Configuration Management*, U.S. Department of Energy, Washington, D.C.
12.112. DOE STD 1189 2016, *Integration of Safety into the Design Process*, U.S. Department of Energy, Washington, D.C.
12.113. DOE-STD-3007-2017, *Preparing Criticality Safety Evaluations at DOE Nonreactor Nuclear Facilities*, U.S. Department of Energy, Washington D.C.
12.114. DOE-STD-3009-94-CN3, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*
12.115. DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, U.S. Department of Energy, Washington D.C.
12.116. DOE-STD-5506-2021, *Preparation of Safety Basis Documents for Transuranic (TRU) Waste Facilities*, U.S. Department of Energy, Washington D.C.
12.117. DOE-STD-1104-2016, *Review and Approval of Nuclear Facility Safety Basis and Safety Design Basis Documents*, U.S. Department of Energy, Washington, D.C.
12.118. OSHA-STD-1910.119-2019, Process Safety Management of Highly Hazardous Chemicals. *Occupational Safety and Health Standards – Special Provisions for Air Contaminants*, U.S. Occupational and Health Administration, Washington, D.C.

Appendix A
Reserved

Appendix B
DFHLW Project Safety Design Basis Milestone Chart

Appendix B
DFHLW Project Safety Design Basis Milestone Chart

The following schedule is based on the best available information at time of issue. It is intended to illustrate the planned approach and is not considered to be a commitment to forecast. As this SDS is revised this schedule will be replaced with the latest information to reduce risk and increase fidelity.



Appendix C
DOE O 420.1C, Change 3, *Facility Safety* - Code Tailoring Evaluations

Appendix C DOE O 420.1C, Change 3, *Facility Safety* - Code Tailoring Evaluations

C.1 ACI 318, Building Code Requirements for Structural Concrete and Commentary (Applicable to HLW Facility)

Revision: 1999

Sponsoring Organization: American Concrete Institute

HLW Facility Specific Tailoring

The following tailoring of ACI 318-99 is required for use by the DFHLW Project contractor as an implementing standard for design of reinforced concrete for Seismic Category III SSCs, as noted. ACI 318-2022 is not tailored and is referenced in the COR applicable to DFHLW support facilities.

Section 9.2 Required Strength

The following additional load combinations from the *Uniform Building Code*, 1997, Section 1612.2.1, shall be included in the load combinations evaluated for design of reinforced concrete:

Equation (12-5): $1.2D + 1.0E + (f_1L + f_2S)$

Equation (12-6): $0.9D \pm (1.0E \text{ or } 1.3W)$

Justification: The additional load combinations implemented are not identified in the ACI load combinations. These combinations are evaluated to ensure adequate equivalency with commercial design in accordance with the UBC.

Section 21.2.1.3

Seismic detailing requirements for “moderate seismic risk” will be used.

Justification: The “moderate SC-I risk” classification is consistent with the Seismic Category III, which is an important facility in seismic zone 2B.

General (no specific chapter)

Design of concrete anchorage will follow the requirements of ACI 349-01, Appendix B.

Justification: This design standard represents the current industry approach to design of concrete embedment. This design method has been adopted by ACI 349 committee and used in the 2001 edition for Appendix B. The load factors are lower than those identified for safety related structures applicable to higher seismic classification. The load factors in this publication are appropriate for use in important commercial structures commensurate with SC-III.

C.2 ACI 318-22, Building Code Requirements for Structural Concrete and Commentary (Applicable to HLW Support Facilities)

Revision: 2022

Sponsoring Organization: American Concrete Institute

WTP Specific Tailoring

The following tailoring of ACI 318-22 is required for use by the WTP contractor as an implementing standard for design of reinforced concrete for NDC-1 and NDC-2 SSCs, as noted:

Chapter 5, Table 5.3.1 Load combinations

Revise Table 5.3.1 with the following:

Load Combination	Equation	Primary Load
U = 1.4D	(5.3.1a)	D
U = 1.2D + 1.6L + (0.5L_r or 0.3S or 0.5R)	(5.3.1b)	L
U = 1.2D + (1.6L_r or 1.0S or 1.6R) + (1.0L or 0.5W)	(5.3.1c)	L_r or S or R
U = 1.2D + 1.0W + 1.0L + (0.5L_r or 0.3S or 0.5R)	(5.3.1d)	W
U = 1.2D + 1.0E + 1.0L + 0.15S	(5.3.1e)	E
U = 0.9D + 1.0W	(5.3.1f)	W
U = 0.9D + 1.0E	(5.3.1g)	E

Justification: The factor applied to the snow loads are revised to align with ASCE 7-22.

C.3 ACI 349, Code Requirements for Nuclear Safety-Related Concrete Structures (Applicable to HLW Facility)

Revision: 2001

Sponsoring Organization: American Concrete Institute

HLW Facility Specific Tailoring

The following tailoring of ACI 349-01 is required for use by the DFHLW Project contractor as an implementing standard for structural design. ACI 349-2013 is not tailored and is referenced in the COR applicable to DFHLW support facilities.

Chapter 9 Required Strength

The thermal load component of the seismic and thermal load combination nos. 4 and 8 may be omitted under certain conditions, if these load combinations result in stresses exceeding the code allowable, in accordance with Los Alamos National Laboratory memo ENG-DECS-05-066, *Combination of Thermal and Seismic Loads for the Hanford Waste Treatment Plant Design* (CCN 133337).

Justification: Los Alamos National Laboratory memo ENG-DECS-05-066, *Combination of Thermal and Seismic Loads for the Hanford Waste Treatment Plant Design* (CCN 133337) provides the technical basis to omit the thermal load component from the seismic and thermal load combinations under certain conditions. The omission, which is only allowed in instances where these load combinations result in stresses exceeding ACI 349-01 code allowable, is justified on the basis of the thermal load being self-relieving, displacement-controlled, and the consideration of cracked sections allowed in ACI 349. The omission of thermal loads in the limited conditions noted in ENG-DECS-05-066 (CCN 133337) does not affect the safety of the design.

Chapter 21

Replace Chapter 21 of ACI 349-01 with Chapter 21 of ACI 318-99, while maintaining the following specific provisions of ACI 349-01 Chapter 21 as identified in:

- Section 21.2.7 (anchorage)
- Section 21.6.1 (height/length criteria)

Justification: Chapter 21 of ACI 349-01 is based on criteria from ACI 318-95. The American Concrete Institute completed a major revision of ACI 318 between the years 1995 and 1999 with respect to seismic proportioning and detailing. The DFHLW Project wishes to adopt the most current methodology for seismic detailing as presented in ACI 318-99 Chapter 21 pertaining to structures in high seismic risk region, in lieu of that presented in ACI 349-01 Chapter 21.

The HLW Facility reinforced concrete structures (designated Seismic Category I) of the DFHLW Project are large shear wall and slab structures of heavy proportions, which exhibit small lateral deflections. ACI 349-01 Chapter 21 describes that at a height-to-length (h/l) ratio of less than 2, the concrete walls act in shear with insignificant bending deformation, thus boundary elements are not required. This criteria, along with the requirements for anchorage, are key elements of the ACI 349-01 design philosophy contained in Chapter 21.

The purpose of maintaining the specific sections of ACI 349-01 Chapter 21 as cited above is to ensure that the specific provisions of ACI 349-01 are maintained while incorporating the more current methodology for seismic detailing requirements of ACI 318-99.

Notes:

1. For the purpose of determining the need for boundary elements, the h_w/l_w criterion of ACI 349-01 shall be applied for the entire wall (where h_w shall be defined as the total height of the wall and l_w shall be defined as the length of the wall).
2. For the purpose of determining the need for boundary elements using the 0.2f'_c criterion, the compressive stress in the shear wall (or shear wall segment) shall be determined by considering the axial compression and in-plane bending behavior of the wall (or shear wall segment) acting as a "beam". The maximum compressive stress may be determined by using the formula, $P/A \pm MC/I$ (where C is lever arm or the distance from neutral axis to the extreme fiber, A is the area of column, and I is the second moment of area) based on the axial loads (i.e., P) and moments (i.e., M) computed by integrating the stresses obtained from an explicit finite element model (e.g., GTSTRUDL model) and assuming a rectangular cross section for the shear wall (or shear wall segment). Alternatively, the "beam" properties may include the effects of the cross walls, in which case the axial loads (i.e., P) and moments (i.e., M) shall be computed by including the stresses on the cross walls.
3. Strain Criteria (Tailoring of ACI 318-99)

Section 21.6.6.3 Walls

In addition to the provisions of this section, boundary elements are not required when the concrete compressive strain, resulting from the worst-case loading combination, does not exceed 0.002.

Justification: Continued use of a concrete compressive stress limit of 0.2f_c' for wall boundary element requirements has been determined to be very conservative. Therefore, a special system of design that utilizes a concrete compressive strain limit of 0.002 for wall boundary element requirements is warranted. For further discussion, see 24590-HLW-RPT-CSA-03-013.

Section 21.7.5.3 Diaphragms

In addition to the provisions of this section, boundary elements are not required when the concrete compressive strain, resulting from the worst-case loading combination, does not exceed 0.002.

Justification: Continued use of a concrete compressive stress limit of 0.2f_c' for diaphragm boundary element requirements has been determined to be very conservative. Therefore, a special system of design that utilizes a concrete compressive strain limit of 0.002 for diaphragm boundary element requirements is warranted. For further discussion, see 24590-HLW-RPT-CSA-03-014.

Section 21.7.8.1 Diaphragms

In lieu of the provisions of this section, proportion reinforcement across the entire width of the diaphragm to resist the factored axial forces and moments acting in the plane of the diaphragm.

Justification: The finite element analysis is the best available description of the structural response of the slabs acting as diaphragms to the various load combinations. Therefore, the finite element results will be utilized to determine the stress distribution across the entire width of the diaphragm. Placement of reinforcement will be distributed accordingly.

Section B.3.6 Embedment Design

Performing ductility checks per ACI 349-01, Section B.3.6 is intended to result in:

- A shear ductility check that states that the embedment steel is ductile in shear when the nominal steel strength is less than 85 % of the nominal concrete shear strength in breakout or pryout, whichever is lower; and
- A tension ductility check that states the embedment steel is ductile in tension when the nominal steel strength is less than 85 % of the nominal concrete tension strength in breakout, pullout or side face blow out, whichever is the lowest.

Justification: ACI 349-06, Appendix D, Section D.3.6.1 provides clarification of the requirements specified in the language in ACI 349-01, Appendix B, Section B3.6 with respect to the intent of the ductility check for embedment anchorage. The change is acceptable because this change provides clarification to the design requirements and is essentially equivalent to Section D.3.6.1 and meets the intent of ACI 349-01.

Section B.6.3 Concrete pryout strength of anchor in shear

ACI 349-01 Appendix B, Section B.6.3, "Concrete pryout strength of anchor in shear," as published only provides the shear equation for a single anchor and omitted the equation for a group of anchors. To calculate pryout strength for a group of anchors in shear (***V_{cpg})*** apply the following:

The nominal pryout strength for a group of anchors, ***V_{cpg}****, shall not exceed:*

$$V_{cpg} = k_{cp} N_{cbg}$$

where $k_{cp} = 1.0$ for $h_{ef} < 2.5$ in.; $k_{cp} = 2.0$ for $h_{ef} \geq 2.5$ in.; and N_{cbg} shall be determined from Eq. (B-4b) found in Section B.5.2.1. Note that $\mathbf{N_{cbg}}$ may be recomputed to reflect all the anchors in shear.

Justification: ACI 349-01 Appendix B, Section B.6.3.1 is silent concerning determining pryout strength in shear for a group of anchors. This code omission results in an excessively conservative anchor design when utilized for a group of anchors. The ACI committee has recognized this omission and has resolved the issue by inclusion of the above equation in ACI 349-06, Appendix D, Section D.6.3.1. Implementation of this clarification is directly comparable and essentially equivalent to and meets the intent of ACI 349-01.

C.4 ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures (Applicable to HLW Support Facilities)

Revision: 2013

Sponsoring Organization: American Concrete Institute

WTP Specific Tailoring

The following tailoring of ACI 349-13 is required for use by the WTP contractor as an implementing standard for design of reinforced concrete for NDC-3 and NDC-4 SSCs, as noted:

Chapter 9 – Section 9.2 Required Strength

Revise Equations 9-2, 9-3, and 9-5

$U = 1.2(D + F + T_o + R_o) + 1.6\ (L + H) + 1.4C_{cr} + (0.5L_r \text{ or } 0.3S \text{ or } 0.5R)$ (9-2)

$U = 1.2(D + F + T_o + R_o) + 0.8\ (L + H) + 1.4C_{cr} + (1.6L_r \text{ or } S \text{ or } 1.6R)$ (9-3)

$U = 1.2(D + F + R_o) + 1.6\ (L + H) + W$ (9-5)

Justification: The factor applied to the snow and wind loads are revised to align with ASCE 7-22.

Section 9.2 – Required Strength

The thermal load component of the seismic and thermal load combination nos. (9-6) and (9-9) may be omitted under certain conditions, if these load combinations result in stresses exceeding the code allowable, in accordance with Los Alamos National Laboratory memo ENG-DECS-05-066, *Combination of Thermal and Seismic Loads for the Hanford Waste Treatment Plant Design* (CCN 133337). Note: ACI 349-01 Load combination 4 and 8 correlate to ACI 349-13 Load combination (9-6) and (9-9).

Justification: Los Alamos National Laboratory memo ENG-DECS-05-066, *Combination of Thermal and Seismic Loads for the Hanford Waste Treatment Plant Design* (CCN 133337) provides the technical basis to omit the thermal load component from the seismic and thermal load combinations under certain conditions. The omission, which is only allowed in instances where these load combinations result in stresses exceeding ACI 349 code allowable, is justified on the basis of the thermal load being self-relieving, displacement-controlled, and the consideration of cracked sections allowed in ACI 349. The omission of thermal loads in the limited conditions noted in ENG-DECS-05-066 (CCN 133337) does not affect the safety of the design.

C.5 ANSI/AISC N690-94, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities" (Applicable to HLW Facility)

Revision: 1994

Sponsoring Organization: American National Standards Institute/American Institute of Steel Construction

WTP Facility Specific Tailoring

The following tailoring of ANSI/AISC N690 is required for use by the WTP Project contractor as an Implementing Standard for structural design.

Page 22, Section Q1.5.7.1 Primary Stresses

Revise the stress limit coefficients for compression in Table Q1.5.7.1 as follows:

- 1.3 instead of 1.5 [stated in footnote (c)] in load combinations 2, 5, and 6
- 1.4 instead of 1.6 in load combinations 7, 8, and 9
- 1.6 instead of 1.7 in load combination 11

Justification: These changes are made for consistency with the NRC requirements of Appendix F of Section 3.8.4 of NUREG-0800, Revision 2.

Page 22, Section Q1.5.7.1 Primary Stresses

Delete the following load combinations:

4. D + L + Eo

6. D + L + Ro + To + Eo

Justification: These load combinations are required for evaluation of an Operation Basis Earthquake (OBE). The WTP project has not identified an OBE event.

C.6 ANSI/AISC N690, Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities (Applicable to HLW Support Facilities)

Revision: 2018

Sponsoring Organization: American National Standards Institute/American Institute of Steel Construction

HLW Facility Specific Tailoring

The following tailoring of ANSI/AISC N690 is required for use by the DFHLW Project contractor as an Implementing Standard for structural design.

Page 12, Section 5a Normal Load Combinations

Revise load combination NB2-2 and NB2-3:

$1.2(D + R_o + F) + 1.6(L + H) + (0.5Lr \text{ or } 0.3S \text{ or } 0.5R) + 1.2T_o + 1.4C$ (NB2-2)

$1.2(D + R_o + F) + (1.6L_r \text{ or } 1.0S \text{ or } 1.6R) + 0.8(L + H) + 1.2T_o + 1.4C$ (NB2-3)

Justification: The factor applied to the snow loads are revised to align with ASCE 7-22.

Page 13, Section 5b Severe Environmental Load Combinations

Revise load combination NB2-4 and NB2-5:

$1.2(D + F + R_o) + W + 0.8L + 1.6H + (0.5L_r \text{ or } 0.3S \text{ or } 0.5R) + T_o + C$ (NB2-4)

$1.2(D + F + R_o) + 1.6E_o + 0.8L + 1.6H + (0.2L_r \text{ or } 0.15S \text{ or } 0.2R) + T_o + C$ (NB2-5)

Justification: The factor applied to the snow loads are revised to align with ASCE 7-22.

Page 14, Section 6a Normal Load Combinations

Revise load combination NB2-11 and NB2-12:

$D + (L_r \text{ or } 0.7S \text{ or } R) + Ro + F + H + T_o + C$ (NB2-11)

$D + F + 0.75L + 0.75H + 0.75(L_r \text{ or } 0.7S \text{ or } R) + T_o + C$ (NB2-12)

Justification: The factor applied to the snow loads are revised to align with ASCE 7-22.

Page 14, Section 6b Severe Environmental Load Combinations

Revise load combination NB2-13 and NB2-14:

$D + R_o + F + 0.6W + 0.75(L + H) + C + 0.75(L_r \text{ or } 0.7S \text{ or } R) + T_o$ (NB-2-13)

$D + R_o + F + E_o + 0.75(L + H) + C + 0.75(L_r \text{ or } 0.7S \text{ or } R) + T_o$ (NB-2-14)

Justification: The factor applied to the snow loads are revised to align with ASCE 7-22.

C.7 ANSI/ISA-67.04.01, Setpoints for Nuclear Safety-Related Instrumentation

Revision: 2018

Sponsoring Organization: American National Standards Association/International Society for Automation (formerly The Instrumentation, Systems, and Automation Society)

HLW Facility Specific Tailoring

The following tailoring of ISA-67.04.01 is required for use by the DFHLW Project as an implementing standard for SC and SS control system design.

All Sections Clarification of Nuclear Power Plant Terminology

The terms "nuclear power plants" and "nuclear reactor facilities" will be taken to mean the HLW Facility.

Justification: Clarifies how the standard will apply to the DFHLW Project.

The term "nuclear safety-related instrumentation" will be replaced by the term "safety instrumentation".

Justification: See also Section 3.10 below. For the DFHLW Project, the correct term is "safety instrumentation."

The term "safety limit" will be replaced by the term "safety or design limit" for the HLW.

Justification: See also Section 4.1 below. For the DFHLW Project, setpoint calculations will be performed using this standard to protect both design limits and safety limits.

Section 3, Definitions

For the HLW Facility, the following definition changes apply:

3.7 Design basis: The information that identifies the specific functions to be performed by structures, systems, or components of the facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design.

Justification: The definition is appropriate for use on the DFHLW Project.

3.11 Instrument channel – delete the reference to IEEE Std. 603 at the end of the definition.

Justification: Per DOE O 420.1.C Change 3, IEEE 603 is a guidance) standard. The definition is appropriate for use on the DFHLW Project for control system design.

3.17 Safety instrumentation: safety-class or safety-significant instrumentation which is essential to ensure: 1) the integrity of the boundaries retaining the radioactive materials or hazardous chemicals; 2) the capability to place and maintain the facility in a safe state; or 3) the capability to prevent or mitigate the consequences of facility conditions that could result in radiological or chemical exposures to the general public or workers in excess of appropriate limits.

Justification: This replacement term / definition uses the DFHLW Project definition of safety function with this term.

3.20 Safety limit: limits on process variables associated with those safety class physical barriers, generally passive, that are necessary for the intended facility function and that are required to guard against the uncontrolled release of radioactive material.

Justification: The definition is from 10 CFR 830.

Add the following definition:

3.27 Design limit: limit on a process variable or a condition determined in the safety analysis to be necessary to prevent a challenge to a Safety barrier or to prevent an unacceptable release of material.

Justification: Definition gives wording that is appropriate to usage at the HLW Facility.

Section 4, Establishment of Setpoints

In the second paragraph, examples of setpoints for which rigorous setpoint methodology should be used are changed to "for example, those associated with safety significant instruments."

Justification: The examples given are those related to Reactor Protection System, Emergency Core-Cooling Systems, Containment Isolation, and Containment Heat Removal. These are specific to nuclear power plants. The phrase is revised to address HLW Facility applicability.

Section 4.1, Safety Limits

Revise the section to read:

Safety limits and design limits are determined in the HLW Facility safety analysis to prevent release of unacceptable levels of material or to prevent a challenge to a safety barrier. For the purpose of this standard, both limits are considered to be addressed by the term *safety limit*. Safety limits can be defined in terms of directly measured process variables such as pressure or temperature. Safety limits can also be defined in terms of a calculated variable involving two or more measured process variables.

Justification: Wording is changed to be specific to the usage at the DFHLW Project, and to indicate that the standard is applied to both safety limit and design limit applications at the DFHLW Project.

Section 4.2, Analytical Limits

Revise the wording "Updated Final Safety Analysis Report (UFSAR)" to read "Documented Safety Analysis."

Justification: Wording is changed to be specific to the usage appropriate for the DFHLW Project.

Section 4.4, Choosing Trip Setpoints

Item d) 3) – revise the wording "safe shutdown or operating basis earthquake" to read "design basis earthquake."

Justification: Wording is changed to be specific to the usage appropriate for the DFHLW Project.

Section 7, References

IEEE section of references – delete the reference to IEEE 603.

Justification: Per the tailoring for IEEE 603, it is applicable only to the HLW Facility SC electrical power systems. The tailoring for ANSI/ISA-67.04.01 has removed references to IEEE 603.

C.8 ASME AG-1

Revisions: 1997 (R2000) (dubbed historical) & 2019

For discussion of historical code editions utilized see 24590-WTP-ES-HV-23-001 Section 3.3

Sponsoring Organization: The American Society of Mechanical Engineers

DFHLW Project Specific Tailoring

The DFHLW Project follows different editions of AG-1 depending on when the equipment was designed and procured. Equipment purchased and design issued after revision 2 of the HLW Facility COR is required to meet the ASME AG-1-2019. For previously procured/designed equipment, the SSC design drawings and specifications document the code edition (typically 1997 (R2000)) that apply. It is not intended that delivered or designed SSCs will be upgraded to the AG-1-2019 edition during the EPC phase of the project. Tailoring of code sections may be applicable to only one edition or both and is specified below.

AG-1 is written primarily for use in nuclear power plants and it references/requires use of ASME Section III and B31.1 for piping and tubing. The DFHLW Project references ASME B31.3, as defined in the COR, as the primary Code for piping and tubing. when AG-1 cites ASME Section III or B31.1 for piping and tubing requirements, ASME B31.3 may be used as a suitable alternative, consistent with the remainder of the piping and tubing on the Project.

The following tailoring of ASME AG-1 is required for use by the DFHLW Project as an implementing standard for the use of safety radial HEPA filter systems. Where not specifically identified herein, the remainder of the code requirements are invoked.

The following is only applicable to historical design/SSCs e.g., 1997 (R2000)

Section FK from AG-1-2015 is added as an addendum to ASME AG-1-1997 edition invoked on the project. Use the 2015 edition for any cross references out of section FK e.g., when FK says look at section AA, use the 2015 edition.

AG-1-1997 (R2000) Page 228.9; Article HA-2000 Reference Documents

Revise Article HA-2000 as follows:

Change the code edition of ASME N509 as applied as a referenced (daughter) standard to AG-1 from 1989, reaffirmed December 6, 1996, to 2002.

Justification: The version of the ASME N509 Standard currently referenced as a daughter by AG-1 was issued in 1989 and reaffirmed in 1996. At the time the N509-1989 (R1996) code was selected to be a daughter of AG-1, the ASME AG-1 code did not include requirements for HEPA filter housings. These requirements were later added in the 2000 Addenda to the AG-1 code. The ASME N509-2002 edition does not provide component requirements for HEPA filter housings and HEPA filters but instead refers the user to AG-1 for this information. Therefore, by making this change it will reduce potential redundancies and conflicts.

AG-1-2019 – Tailoring above not required.

AG-1-1997 (R2000) Sub-article HA-4420 Access Doors and Panels

AG-1-2019 Sub-article HA-4420 Access Doors and Panels

Revise sub-article HA-4420 as follows for remote change housings:

Not applicable. The requirements of this article are not applicable to Remote Change Radial HEPA Filter Housings; the access doors and panels shall satisfy HA-4500, Pressure Boundary Leakage, and HA-5300, Pressure Boundary Leakage Testing.

Justification: Remote housings are not designed to "incorporate a means for adjusting compression forces, gasket compression...." There are no hinges or latches in the design, and they are not designed for manual operation. Therefore, the requirements described in this code article are not applicable.

The remote housing design requires remote access, using a grapple to manipulate doors in a cave environment that may become subject to contamination and high radiation fields. The design incorporates low maintenance features not subject to failure (i.e., vertical housings and heavy doors). The housing doors seal by virtue of their weight alone. Door guides are included. A bar placed across the tops of the doors (and pinned in position) is used to ensure the doors remain in place during seismic events.

AG-1-1997 (R2000) Paragraph HA-4443 Clamping Mechanism

AG-1-2019 Paragraph HA-4443 Clamping Mechanism

Revise paragraph HA-4443 as follows for remote change and safe change radial HEPA housings:

Replace the text with: The requirements of this article are not applicable to Safe Change and Remote Change Radial HEPA Filter Housings. For safe change housings with fluid seals the filter clamping mechanism shall be capable of retaining the filter in position during DBE seismic events for housings serving a seismic safety function. The clamping mechanism, in general, is provided to provide positive indication to the operator that the filter is seated against the housing sealing surface at the conclusion of the filter change process, with the housing knife-edge embedded in the filter gel seal.

Justification: The remote change housings are not side access housings and are not designed for manual operation. There are no clamping mechanisms or filter indexing mechanisms. The weight of the remote filter and differential pressure across the filter is relied upon to ensure that the knife-edge is embedded into the fluid seal.

The safe change housings are front access and are not walk-in style. The filter is not accessed from its side. Therefore, filter retrieval features and filter indexing mechanisms do not apply. A clamping mechanism that is capable of moving the filter (e.g., for side access housings) is not required. The safe change housings are designed to allow a person to insert and remove each filter.

AG-1-1997 (R2000) and AG-1-2019 Sub-article FK-4100 General Design

Revise second paragraph of sub-article FK-4100,

"The total media area provided within the filter pack shall be such that maximum media velocity is 5 ft/min (1.5 m/min) at the rated flow."

Replace the text with: For Remote Change and Safe Change Radial HEPA Filters, the total media area provided within the filter pack shall be such that maximum media velocity is 6.5 ft/min (2.0 m/min) at the rated flow.

Justification: The radial filter design is based upon a UK Atomic Energy Standard Specification AESS 30/95100. This Standard contains an equivalent requirement to that found in AG-1. It states: "The effective area of filter medium used for each insert shall be not less than 3.0 sq m for every 100 l/s rated airflow." The Project proposes to meet this criterion. Converting these metric units for a UK 950 l/s (~2,000 cfm) rated filter equates to approximately 6.5 ft/min media velocity or a minimum of 308 sq. ft of media.

The DOE Nuclear Air Cleaning Handbook (Reference DOE-HDBK-1169-2003 Chapter 2.3.7 and Figure 2.8(a)) illustrates the importance and intent behind this code requirement. AG-1 Subsubarticle FK-1130 states that a HEPA filter shall have *"a minimum efficiency of 99.97% (that is, a maximum particle* *penetration of 0.03%) for 0.3 micrometer diameter test aerosol particles."* This defines the minimum performance of a HEPA type filter. The curves depicted in Figure 2.8(a) of the Handbook show that at 10.5 ft/min air velocity, the 0.30-micron particle size can be expected to penetrate a HEPA filter such that the AG-1 FK-1130 performance requirement would not be met.

Numerous aerosol penetration tests have been performed on the filter design both inside prototype housings and on individual prototype radial filters designed with a media area of 310 sq. ft., or approximately 6.5 ft/min media velocity. Each test demonstrated that a filter design with media velocities of this magnitude and up to 10 ft/min would meet the qualification performance requirements as stated in AG-1 (e.g., 99.97% efficiency or better for penetration of 0.3-micron particles).

Further addition of filter media to meet the more restrictive AG-1 Section FK requirement would possibly result in other undesirable design and performance characteristics (e.g., increased DP, reduced pleat spacing). The filter geometry is also limited by many other design restrictions including available building space, personnel filter handling limitations, and waste disposal package limitations.

AG-1-1997 (R2000) and AG-1-2019 Table FK-4000-1

Revise Table FK-4000-1 rating information for the 2,000 acfm filter as follows for safe change HEPA radial filter designs:

TABLE FK-4000-1 (TAILORED FOR SAFE CHANGE FILTER CONFIGURATION)

TYPE 1 RADIAL FLOW HEPA FILTER – NOMINAL RATINGS

Maximum Rated Air Flow		Maximum Resistance	
(acfm)	(m^3/hr.)	Inches WC	Pa
40	68	1.3	325
100	170	1.3	325
250	425	1.3	325
500	850	1.3	325
1000	1700	1.3	325
1500	2550	1.3	325
2000	3400	1.6	400

Revise Table FK-4000-1 rating information for the 2,000 acfm filter as follows for remote change HEPA radial filter designs:

TABLE FK-4000-1 (TAILORED FOR REMOTE CHANGE FILTER CONFIGURATION)

TYPE 1 RADIAL FLOW HEPA FILTER – NOMINAL RATINGS

Maximum Rated Air Flow		Maximum Resistance	
(acfm)	(m^3/hr.)	Inches WC	Pa
40	68	1.3	325
100	170	1.3	325

250	425	1.3	325
500	850	1.3	325
1000	1700	1.3	325
1500	2550	1.3	325
2000**	3400	2.3*	575

* Based on manufacturer testing, it has been demonstrated that the clean differential pressure of the remote change filter design when exposed to a rated air flow of 2000 cfm is bounded by 2.3" W.C. (inclusive of a 2σ margin).

**The filter design has been tested for efficiency performance at 5%, 125% and 150% of the rated flow. This testing indicates that the filter performs at or above the HEPA definition efficiency of 99.97% when subjected to these flow rates. This is also in excess of air permit efficiency standards for the HEPAs. Therefore, exposure of the HEPA to transient flows as low as 5% of rating or as high as 150% of rating are determined to be acceptable, as demonstrated by testing.

Justification: *The remote change HEPA filter design shall utilize roughly the same pack as the safe change HEPA filter design. However, the remote change filter configuration must also be compatible with the remove handling/overhead crane grapple designed for the HLW and PT facilities. Therefore, there must be an area inside the filter that the grapple may interface with. This requires the filter orifice of the remote change filter to be narrower than the orifice of the safe change filter, such that the grapple has an unobstructed area to hook under. When the area of the filter orifice is reduced, it follows that the resistance of the filter is increased.

**ASME AG-1 code typically defines the range of filter functional efficiency testing at 20% and 100% of rated flow for radial flow HEPA filters (refer to ASME AG-1 Section FK-5120). However, it is acknowledged that radial flow designs may encounter flows outside of this range.

In both cases, the proposed tailoring of ASME AG-1 Section FK is justifiable based on the results of filter testing.

AG-1-1997 (R2000) and AG-1-2019 Paragraph FK-6211 Flatness and Squareness

Revise Paragraph FK-6211 (a) as follows for remote change and safe change radial HEPA filter designs:

Type 1 filter flange and end cap tolerances shall meet the following criteria: parallel within $^1/_8$ in., flat within $^1/_{16}$ in.

Justification: TAILORING OF PARALLELISM TOLERANCE: The tailoring presented above changes the code requirement for flange to end cap parallelism from 1/16 in. to 1/8 in. For the Remote Change Filter, the inlet flange, which includes the gel channel with a nominal width of 3/4 in., creates the seal and supports the filter inside the housing. The outlet end cap is fully suspended inside the housing by the opposite inlet flange (i.e., outlet end cap does not touch the housing and is not used to form the seal). Parallelism to within 1/8 in. will ensure that an adequate housing-to-filter seal is created. For the Safe Change Filter, as with the remote filter, the seal is formed by insertion of a housing knife-edge into a filter gel filled channel with a nominal width of 3/4 in. The gel channel is located on the filter inlet flange. Parallelism to within 1/8 in. will ensure an adequate housing-to-filter seal is created.

TAILORING OF SQUARENESS TOLERANCE: The "squareness" tolerance from FK-6211 is being addressed with a tolerance for circular runout as stated in tailoring for FK-6212. Circular runout controls the cumulative variations that may be present in the positional relationship between the inlet flange and outlet end cap. Inspection for circular runout is equivalent to and meets the code requirement to maintain the squareness characteristic while considering the entire length of the filter. Maintaining radial filter circular runout to within the 3/32" tolerance will ensure the filter forms an adequate seal within the filter housing.

AG-1-1997 (R2000) and AG-1-2019 Paragraph FK-6212 Overall Dimensions

Replace Paragraph FK-6212 as follows for the remote change and safe change radial HEPA filter design: Type 1 filter length shall be (+0 / -$^{1}/_{8}$ in.), circular runout of filter flange with respect to the filter end cap shall be within 3/32 in., all other dimensions ±$^{1}/_{16}$ in.

Justification: "Seal ring" and "seal face" are terms specific to Section FK radial filters with gaskets and therefore dimensions and tolerances associated with these terms are not applicable to the Type 1 gel seal radial filters to be used.

TAILORING OF CONCENTRICITY: Concentricity is the condition in which the axes of all cross-sectional elements of a surface of revolution are common to the axis of a datum feature. Concentricity is being replaced with a tolerance for circular runout as a more practical method to verify roundness. Runout refers to the result of rotating a part about its central axis while measuring with a dial indicator its surface deviation from perfect roundness. With circular runout, the dial indicator is not moved along the direction of the axis of the part (as with "total runout"). Circular runout is therefore applied independently at each single circular element along the length of the part as the part is rotated through 360 degrees. The tolerance for circular runout provided in the tailored text controls the cumulative variations that may be present in the positional relationship between the inlet flange and outlet end cap.

The 3/32 in. tolerance provided for circular runout will ensure the filter forms an adequate seal within the filter housing.

AG-1-1997 (R2000) and AG-1-2019 Section FG Mounting Frames

Not Applicable.

Justification: The ASME Committee on Nuclear Air and Gas Treatment (CONAGT) has stated that Section FG only applies to walk in housings. None of the filter housings (i.e., radial or axial filter designs) to be installed on the RPP-WTP Project is a "walk in" design. Reference ASME Technical Interpretation File # 05-990, RPP-WTP CCN # 107935).

AG-1-1997 (R2000) and AG-1-2019 Page 607;

Paragraph TA-4632 Airflow Distribution Test (AD)

Revise Paragraph TA-4632 as follows for remote change and safe change radial HEPA housings:

Replace "downstream" with "upstream". Add for clarity: "For Remote Change and Safe Change Radial HEPA filter banks, flow measurement location is upstream vs. code required downstream."

Justification: The requirement for flow measurements to be taken downstream of each HEPA filter in a bank is in order to verify equal flow distribution between filters in a bank. In traditional axial flow systems, a measurement location downstream is preferred due to the improvements in the flow conditions (i.e., flow straightening) inside the housing created by the filter itself. However, due to the difference in configuration created by the radial filter, the flow profile both entering and exiting the filter is extremely complex (i.e., not uniform over the filter face). Testing and analysis (computational fluid dynamic models) performed on prototype units to date have determined that taking the flow measurement upstream and inside the filter (inlet) using a hot wire anemometer provides the most repeatable measurement. Accuracy of the measurement is still hindered by flow conditions and anemometer placement; however, increased precision is obtained by taking an average of multiple measurements at multiple locations within each filter inlet.

Predicted results from CFD modeling have agreed with actual field measurements using this technique. The Project intends to design (based on the prototype tests) and use an anemometer instrument developed specifically for the radial filter design and place it at the inlet (i.e., upstream) side of the filter. Verification, in the field, of acceptable air distribution between filters in a bank can then be accomplished, as the code requires.

AG-1-1997 (R2000) Page 111; Section BA-4162 Vibration, Centrifugal Fans

Supplement Section BA-4162 as follows for balancing multi-stage blowers:

Since Section BA-4162 of ASME AG-1 is not applicable for multi-stage blowers used in ventilation/offgas systems, multi-stage blowers shall be balanced to Quality Grade 2.5 of ISO 1940-1:2003, Mechanical Vibration - Balance Quality Requirements for Rotors in A Constant (Rigid) State - Part 1: Specification And Verification Of Balance Tolerances. Where the pressure developed in the blower is higher than the upper limits of BA-4162, use ASME PCT-10.

Justification: ASME AG-1 is not applicable for multi-stage blowers. ASME AG-1 Section GC is applicable to multi-stage blowers. However, Section GC is in the course of preparation and is not available for use at this time.

AG-1-1997 (R2000) Sub-article FC-I-3270 Combustible Material

AG-1-2019 FN-4260, Combustible Material

Revise text of Subarticle FC-I-3270 of ASME AG-1 1997 (FC-I-3260 of ASME AG-1 2015) and ASME AG-1-2019 FN-4260 as follows for safe change and remote change radial flow HEPA filter designs:

Replace existing text with:

AG-1-1997 (R2000)

The combustible material in the filter media shall not exceed 10% by weight when tested as specified in FC-I-4226 of ASME AG-1 1997.

AG-1-2019

The combustible material in the filter media shall not exceed 10% by weight when tested as specified in FN-5250.

Justification: The purpose of a limit on the combustible-material, or loss-on-ignition (LOI) content of a filter media is twofold. One is to ensure that the DOP aerosol particle penetration of the filter element does not exceed 3% following filter exposure to 700°F for 5 minutes and subsequent cooldown to room temperature. The second is to ensure that the filter media is self-extinguishing following its direct exposure to an open flame. The functional fulfillment of these requirements is demonstrated via test when the filter design meets the performance specifications of Subarticles FK-5150 and FK-5160.

The addition of a scrim of woven glass fiber filaments as reinforcement to a filter media can necessitate the use of additional combustible materials in order to bond the scrim onto one or both sides of the media. This may increase the combustible material content up to 10% by weight of the media as compared to the upper limit of 7% by weight specified in FC-I-3270 of ASME AG-1 1997 and FN-5250 of ASME AG-1-2019.

A precedent for the application of material composites having an overall higher LOI content, toward enhancing filter pack robustness, is to be found within AG-1 Subarticle FK-4130. The approved filter pack designs B and D of FK-4130 (b) and (d), respectively, incorporate an adhesive in order to bond pleat separators of ribbons or string onto the filter media, without having any constraint imposed upon them via a specified LOI upper limit, for the combination of separators, adhesive, and media, taken as a composite material.

In the context of pack designs having a scrim-reinforced filter media, any designation of the additional combustible material as a filter media constituent - rather than one of the filter pack - is based upon a historical precedent established prior to the utilization of scrim or scrim-reinforced media. With respect to the performance specifications to be met under FK-5150 and FK-5160, there is no discernable significant technical difference between whether the adhesive is allocated to the filter media, or to the filter pack, for the practically relevant pack designs under consideration toward filter qualification.

Because the test conditions of Subarticles FK-5150 and FK-5160 demonstrate the functional fulfillment of the two relevant requirements, an allowance for a greater combustible material threshold is justified. If the filter design passes the tests delineated under FK-5150 and FK-5160, then the DOP aerosol particle penetration following exposure to 700°F for 5 minutes not to exceed 3% and the ability of the filter to self-extinguish after exposure to an open flame are both definitively demonstrated.

AG-1-1997 (R2000) Sub-article FK-4130 Filter Pack

AG-1-2019 Sub-article FK-4130 Filter Pack

Revise bullet "a" of FK-4130 as follows for safe change and remote change radial flow HEPA filter designs: Eliminate text of final sentence ("Separators and media shall not vary more than ¼ in. (6 mm) from a straight line connecting the fixed ends.")

Justification: This pleat straightness requirement applies for both axial flow and radial flow HEPA filter packs using a standard non-reinforced HEPA media. When using a glass scrim reinforcement, the added thickness and resistance to bending of the composite material ultimately make the final pleat linearity more difficult to control than that of the non-reinforced media. The scrim reinforcement acts like a compressed spring and can lead to filter pack distortions when confining forces are not uniformly applied and maintained.

For axial flow filters, the same compressive force is applied to the filter pack on both the upstream and downstream sides of the pack. As a result, a minimal deviation in pleat straightness is expected, and the inlet and outlet sides of the filter pack should have essentially the same pleat linearity.

However, for radial flow designs, there is a greater pleat density at the inlet of the filter pack than at the outlet. It is therefore to be expected that the requirement would be more easily met at the inlet of the filter pack, but that there may be greater pleat deviation from linearity via curvature on the outlet side of the pack, where the pleats are more susceptible to movement. For non-reinforced media, a loose pleat pack is indicative of susceptibility to damage and fatigue. Although the looser pleat packing at the outlet makes the pack somewhat less rigid than on the inlet side, the high strength of the scrim-reinforced media provides the needed support to the filter pack. In addition, a steel outer guard grille prevents pleat dislocations and resulting distortions in the radial direction.

Test results of prototype scrim-reinforced media radial flow HEPA filters show that the pleat straightness requirement of FK-4130 was not met, but the filters met and far exceeded all other minimum filter performance requirements and criteria set forth in ASME AG-1. Furthermore, all safe change and remote change radial flow HEPA filters will follow the standard practice in DOE facilities for all HEPA filters to be tested three times prior to final use in a facility (once by the manufacturer, once independently at the DOE filter test facility, and once more in the service location, prior to use). Based on the case presented above and the corroboration of acceptability via the final performance testing of prototypical filter elements, this tailoring of ASME AG-1 is justified.

AG-1-2019 AA-3400 Certification of Materials

AA-3400 Certification of Materials requires that pressure boundary and structural materials required for proper function of the air system components have certified material test reports.

Proper function is defined as subcomponents that support the safety function of the parent SSC.

This section also requires certificates of conformance for all other materials, as applicable. For non-safety SSCs procured to AG-1 certificates of compliance are acceptable.

Justification: The project uses a graded approach to the pressure boundary through the cascading ventilation system and applies additional AG-1 characteristics to some components. Additional material certifications are not aligned to project execution of pressure boundary design or are already covered by other material verifications.

AG-1-2019 Section IA Instrumentation and Controls

For Safety Instrumented Systems, this section is replaced with:

SC – Follow ANSI/ISA 61511-1-2018 & IEC/IEEE 60780-323-2016

SS – Follow DOE-STD-1195-2011

For SS/SC instruments not part of a Safety Instrumented System, WTP NQA-1 compliant procedures and processes and the applicable codes and standards listed in the SDS and COR are used.

Non-Safety – Follow applicable HLW Facility COR standards and the DFHLW Project established processes for non-safety controls and instrumentation

Justification: DOE O 420.1C Change 3 specifies how projects should implement safety instrumentation controls. This implementation aligns with this requirement set as tailored in this document. Replacing the requirements reduces redundant and potentially conflicting requirements while maintaining a required level of safety. The codes that replace AG-1 Section IA are performance standards instead of prescriptive standards that apply the same level of safety. Note that there are additional codes and standards defined by the DFHLW Project COR that are applicable and design criteria that are not included here for brevity.

AG-1-2019 Section TA Field Testing of Air Treatment Systems

Clarification: This section is only applicable to field testing after turnover (i.e., after design, and construction completion). The requirements of this section are applicable pre-turnover as referenced by other component sections (e.g., shop qualification testing such as housing pressure test).

C.9 ASME B31.3-1996, Process Piping

There are six items tailored in ASME B31.3

1. Using B31.3 for ductwork
2. Using Appendix P from 2010 to evaluate pressure cycling
3. Using stress intensification factors from 2002 for B16.9 welding tees
4. Using vacuum box leak testing rules inside BC/HTR areas
5. Using volumetric examination for closure welds
6. Exception to 302.2.4 for HPAV affected lines

Revision: 1996 (design rules), latest edition for materials, fabrication, examination, and test

Sponsoring Organization: ASME

DFHLW Vitrification Project Specific Tailoring

The following tailoring of ASME B31.3, *Process Piping*, is required for use as an Implementing Standard for: (1) the fabrication and installation of those portions of the C5V ductwork that are being embedded in concrete, (2) the use of ASME B31.3-2010, Appendix P, Alternative Rules for Evaluating Stress Range for evaluating stress ranges due to pressure cycling and operational load cycling, (3) the use of ASME B16.9 welding tees in accordance with ASME B31.3-2002, (4) use of vacuum box leak testing, (5) the ASME B31.3, paragraph 345.2.3(c), allowance for not leak testing closure welds outside of a closed cell (black cell) and/or hard-to-reach area, (6) the test pressure that is used for piping systems subjected and designed for HPAV detonation events.

- The tailored sections of ASME B31.3 applicable to embedded ductwork will only be utilized to the extent that it will cover the fabrication, installation, and inspection (and associated testing) of Category D fluid service piping being used as C5 ductwork. Air testing requirements for this ductwork will be compliant with ASME AG-1. Below is a description of those portions of ASME B31.3 that apply to fabrication, installation, and inspection of Category D fluid service piping.
- 2010 Appendix P rules will be used to evaluate pressure cycling (except for HPAV loading, which is addressed in the last bullet)
- The tailored sections of ASME B31.3 applicable to welding tees will only be used for ASME B16.9 welding tees. As long as the stress intensification factors from ASME B31.3-2002 are used in the stress analysis for the welding tees, welding tees fabricated to either the 1996 or the 2002 or later edition of ASME B31.3 can be used. Below is a description of those portions of ASME B31.3, Appendix D, Table D300, that apply to welding tees.
- The tailored paragraphs of ASME B31.3 applicable to vacuum box leak testing, in lieu of hydrostatic or pneumatic leak testing, will only be used to leak test full penetration circumferential piping field butt welds inside a closed cell (black cell) and/or hard-to-reach area as defined in Appendix M, out to the first isolation component outside the closed cell (black cell) and/or hard-to-reach area. Further, if the 100 % volumetric inspection using ultrasonic examination per ASME B31.3 paragraph 344.6, is conducted for welds to be vacuum box tested, then the ultrasonic examination shall be conducted using a method that creates and maintains a reproducible computerized image(s) of the entire weld in the axial and radial direction.
- The tailored paragraphs of ASME B31.3 adopting the provisions of ASME B31.3 (c) Addendum paragraph 345.2.3(c) are applicable to all ASME B31.3 piping in all facilities except for closure welds in closed cells (black cell) and/or hard-to-reach areas.

Piping providing a confinement function in accordance with SRD Safety Criterion 4.4-3 will comply with the following sections of ASME B31.3-1996, Process Piping. These sections of ASME B31.3 are applicable for embedded ductwork:
Chapter 3, Materials
Chapter 5, Fabrication
Table 341.3.2, Visual acceptance criteria for Category D fluid service piping

Justification: Due to wall thickness requirements of duct embedded in concrete, piping materials are required. ASME B31.3 will apply to materials, fabrication, and inspection standards as appropriate. Testing requirements for nuclear air treatment systems will be consistent with ASME AG-1.

Piping providing a confinement function in accordance with SRD Safety Criterion 4.4-3 will comply with the following sections of ASME B31.3-1996, Process Piping with the following modification.
ASME B31.3-2010 Appendix P: Alternative Rules for Evaluating Stress Range will be used to evaluate stress ranges due to pressure cycling and operational load cycling to address ASME B31.3-1996 Section 301.10: Cyclic Effects.

Justification: ASME B31.3-1996 Section 301.10 specifies that fatigue due to pressure cycling, thermal cycling, and other cyclic loadings shall be considered in the design of piping. No additional methodology is provided by code of record. Therefore, consideration of cyclic loading other than displacement controlled loading shall be achieved through the alternative rules provided in ASME B31.3-2010 Appendix P. This alternate rule does not apply to HPAV affected confinement piping systems as addressed separately in this Appendix to the SRD.

The design rules and evaluation of piping providing a confinement function will comply with ASME B31.3-1996, *Process Piping*, with the following modification:

In Table D300, the description of welding tee per ASME B16.9 shall be revised so it is consistent with that shown in Table D300 of ASME B31.3-2002:

		Stress Intensification Factor [Notes (2), (3)]			
Description	**Flexibility Factor k**	**Out-of-Plane, i_0**	**In-Plane i_i**	**Flexibility Characteristic, *h***	**Sketch**
Welded tee per ASME B16.9 [Notes (2), (4), (6), (11), (13)]			3/4 i_0 + 1/4		Same as ASME B31.3-1996

This means that for welding tees per ASME B16.9, note 11 in Table D300 is also changed to:

(11) If rx ≥ 1⁄8 Db and Tc ≥ 1.5T, a flexibility characteristic of 4.4 T /r2 may be used.

Justification: The use of a lower flexibility characteristic for welding tees per ASME B.16.9 in accordance with ASME B31.3-2002 will increase both the out-of-plane and in-plane stress intensification factors. The increased stress intensification factors will reduce the allowable out-of-plane and in-plane moments that can be applied to the welding tee and keep the calculated stress below the stresses allowable by ASME B31.3-1996.

Safety piping shall comply with ASME B31.3, Chapter V, Paragraph 345, using the following approach for vacuum box leak testing. Vacuum box leak testing, in lieu of hydrostatic or pneumatic leak testing, may be used to leak test full penetration circumferential piping, field butt welds inside a closed cell (black cell) and/or hard-to-reach area as defined in Appendix M, out to the first isolation component outside the closed cell (black cell) and/or hard-to-reach area, only under the following conditions:

Vacuum Box Leak Test Method - The vacuum box leak test shall be in accordance with a Bubble Test - Vacuum Box Technique method specified in ASME BPV Code, Section V, Article 10, Appendix II, subject to the requirements listed below:

1. Sensitivity of the test shall be demonstrated to be not less than 1E-3 atm-ml/sec at 15 psig.
2. The test pressure shall be a partial vacuum of at least 7 psi below atmosphere, applied to the outside of the weld.
3. The required partial vacuum shall be maintained for at least 20 sec examination time.

   In addition, the following limitations and restrictions shall apply to the application of vacuum box leak testing in lieu of a hydrostatic or a pneumatic leak test:

- Vacuum box leak testing will only be used to leak test circumferential piping field welds inside a closed cell (black cell) and/or hard-to-reach area. This includes any welds in extensions of piping systems contained or originating in accessible areas between the closed cell (black cell) and/or hard-to-reach area boundary and the first isolation valve or device beyond the closed cell (black cell) and/or hard-to-reach area boundary;
- It shall only be used for piping field welds where required to avoid damage to components, ensure the safety to construction workers, perform leak tests of field welds where physical limitations prevent hydrostatic or pneumatic leak testing as prescribed in ASME B31.3 paragraph 345.4 and paragraph 345.5 respectively;
- Pipe welds that are to be vacuum box leak tested will be assessed for suitability. The number of welds to be vacuum box leak tested shall be limited to a maximum of three welds between termination points (two termination or closure welds and one intermediate weld) on a given pipe system except where physical limitations prevent examination by hydrostatic or pneumatic leak testing. DOE will be informed of such exceptions and may at its discretion and within 48 hours of being informed, respond to BNI on the suitability of the use of vacuum box leak testing for such instances. Termination points may be tanks, vessels, valves, etc. (Specifically excluded from the definition of termination points are junctions where the piping changes design class). This could be either the last two closure welds in a closed cell (black cell) and/or hard-to-reach area or the last closure weld in the closed cell (black cell) and/or hard-to-reach area and the last closure weld outside the closed cell (black cell) and/or hard-to-reach area. In addition, vacuum box leak testing would be permitted for the connection welds between construction modules if this is limited to one module-to-module weld per piping run within the cells. This is in addition to termination welds on the piping run. A module is defined as a pre-leak-tested subassembly containing multiple pipe spools;
- Vacuum box leak testing shall be limited to full penetration girth butt welds, on straight pipe or between straight pipe and pipe components of the same nominal pipe size and same wall thickness on both sides of the weld at the weld location. The following configurations are candidates for vacuum box testing:
    1. Straight pipe to straight pipe connection butt welds
    2. Straight pipe to 90° elbow connection butt welds

3. Straight pipe to 45° elbow connection butt welds
4. Straight pipe to concentric reducer connection butt welds
5. Straight pipe to eccentric reducer connection butt welds
6. Straight pipe to butt welding tee connection butt welds
7. Straight pipe to butt welding reduced outlet tee connection butt welds
8. Straight pipe to valve nozzle connection butt welds
9. Straight pipe to tank or vessel nozzle connection welds
10. Straight pipe to safe-end of a weldolet connection butt welds - full penetration butt welded connection only
11. Straight pipe to pipe cap connection butt welds

Prior to the application of vacuum box testing using any of the candidate configurations on piping butt welds, the Contractor must successfully demonstrate to the DOE, for the candidate configuration, that (1) all portions of the weld to be inspected are visible and can be inspected in accordance with the ASME Boiler and Pressure and Vessel Code, Section V, Article 10, Appendix II -; (2) the vacuum box can adequately maintain a partial vacuum of 7 psid; and (3) vacuum box leak testing can be accomplished in the time limits and other requirements established by this procedure. The DOE shall be advised at least 7 days in advance of any demonstration to qualify a new weld configuration so that they can witness the demonstration. The Contractor shall document any demonstration relied upon to justify the use of vacuum box leak testing on a new configuration. Further, vacuum box leak testing shall be conducted with a vacuum box that completely encapsulates the weld, at the test location;

- All welds shall be 100 % volumetrically inspected in accordance with ASME B31.3, paragraphs 344.5 or 344.6. If the 100 % volumetric inspection is conducted using ultrasonic examination per ASME B31.3 paragraph 344.6, then the ultrasonic examination shall be conducted using a method that creates and maintains a reproducible computerized image(s) of the entire weld in the axial and radial direction;
- It shall be limited to welds made using the Orbital welding machines. The only exception is that vacuum leak box testing may be used on manual welds if the 100 % volumetric inspection was conducted by radiography per ASME B31.3 paragraph 344.5;
- The piping systems and or components on both sides of the weld to be vacuum box leak tested shall have been subjected to a hydrostatic leak test in accordance with ASME B31.3 paragraph 345.4, a pneumatic test in accordance with ASME B31.3 paragraph 345.5, a combination pneumatic-hydrostatic leak test in accordance with ASME B31.3 paragraph 345.6, or in the case of components, leak tested in accordance with the Code or Standard applicable to the design of the component;
- At a minimum, a flexibility analysis in accordance with ASME B31.3-paragraphs 319.4.2 (a) and (b) shall be required on any piping systems that contain welds that are to be vacuum leak box tested. In addition, a comprehensive flexibility analysis in accordance with ASME B31.3 paragraphs 319.4.2 (c) and (d) shall be performed on any piping systems that contain welds that are to be vacuum box leak tested when the piping systems have a design temperature greater than or equal to 150 °F;
- For manual welds, the requirements of ASME B31.3 paragraph 344.7.1 (a) through (g) shall be invoked on any weld to be vacuum box leak tested with the exception that the requirement of subparagraph 344.7.1 (e) "… aided by liquid penetrant or magnetic particle examination when specified in the engineering design" shall not be required. For welds made using Orbital welding

machines, the requirements of ASME B31.3 paragraph 344.7.1 (a), (b), (c), (d), and (g) shall be invoked. The requirements of 344.7.1 (e) and (f) shall not be required. The implementation of these requirements shall be documented in the weld inspection report;

- Pipe welds and the associated line numbers that are to be vacuum leak box tested shall be identified in advance of the testing. This identification shall be documented in the controlled document Weld List, which must include this information prior to the initiation of any vacuum box leak testing associated with those welds and line numbers. It is understood that the controlled document Weld List may need to be revised and updated periodically through the construction phase of the DFHLW Project; and
- The following special requirements shall be placed on the training programs used to certify the technicians that will be conducting the vacuum box leak tests:

1. The BNI Construction Manager shall pre-approve the technician qualifying examination(s) for vacuum box leak testing;
2. The BNI Construction Manager shall pre-approve the qualifications of each Level III technician preparing or giving the examinations for vacuum box leak testing;
3. DOE ORP at their discretion shall reserve the right to observe any and/or all practical leak test examinations and review of the results of any and/or all written vacuum box leak test examinations;
4. The minimum topical content of each Level II examination shall be specified by BNI, and approved by DOE;
5. The 80 % correct criteria for passing the examination shall apply to each part of the three part examinations that are to be given;
6. BNI shall provide reasonable assurance that they will take adequate measures to assure the integrity of written examination is maintained; and
7. There shall be several versions of each examination in use to assure Level II knowledge and ability concerning vacuum box leak testing is confirmed.

Justification: The requirement for the vacuum box leak test sensitivity is consistent with the ASME B31.3 requirement for a sensitive leak test as given in ASME B31.3 paragraph 345.8 and for at least 7 psi vacuum and an examination time of at least 20 seconds. The limitations in using vacuum box leak testing better define when this method can be used. DOE ORP may further change the definition and application of these special vacuum box leak testing criteria based on the Contractor’s experience with their use, or the Contractor’s request for a change.

Piping system closure welds outside of a closed cell (black cell) and/or hard-to-reach area, shall comply with the requirements of ASME B31.3, subparagraph 345.2.3(c). When ASME B31.3, subparagraph 345.2.3(c) is invoked the following restrictions shall apply:

- It shall not be invoked on any closure welds on piping systems in a closed cell (black cell) and/or hard-to-reach area. This includes any welds in extensions of piping systems contained or originating in a closed cell (black cell) and/or hard-to-reach area, between the closed cell (black cell) and/or hard-to-reach area boundary and the first isolation valve, or device beyond the closed cell (black cell) and/or hard-to-reach area boundary;
- It shall only be invoked on full penetration butt welds in straight pipe, full penetration butt welds at the safe-end of an equipment nozzle, or full penetration butt welds at the safe-end of branch connections. [The safe-end is defined as the piping to equipment nozzle connecting weld or the branch connection to branch piping connecting welds.];

- The requirements of ASME B31.3(c), subparagraph 345.2.3 (c) shall be met;
- The piping systems and or components on both sides of the closure weld shall have been subjected to a hydrostatic leak test in accordance with ASME B31.3 paragraph 345.4, a pneumatic leak test in accordance with ASME B31.3 paragraph 345.5, a combination pneumatic-hydrostatic leak test in accordance with ASME B31.3 paragraph 345.6, or in the case of components leak tested in accordance with the Code or Standard applicable to the design of the component;
- For manual welds, the requirements of ASME B31.3 paragraph 344.7.1 (a) through (g) shall be invoked with the exception that the requirement of subparagraph 344.7.1 (e) "…aided by liquid penetrant or magnetic particle examination when specified in the engineering design" shall not be required. For welds made using the Orbital welding machines, the requirements of ASME B31.3 paragraph 344.7.1 (a), (b), (c), (d), and (g) shall be invoked. The implementation of these requirements shall be documented in the weld inspection report;
- Piping welds and the associated line numbers for which the closure weld classification is invoked shall be documented in a controlled document Weld List;
- Piping components may include mechanical elements other than piping; and
- In addition, BNI shall incorporate these requirements into the appropriate specification. DOE-ORP may further change the definition and application on the use of closure welds based on the Contractor's experience with their use or the Contractor's request for a change.

Justification: This change does not change the safety function of any pressure boundary components. The requirement to leak test pressure boundary field welds is primarily to ensure the reliability of the welds in addition to the reliability provided by the other required examinations. The exception allowed by ASME B31.3, paragraph 345.2.3 that the final weld connecting piping systems or components which have been successfully tested in accordance with paragraph 345 need not be leak tested provided the weld is examined in-process in accordance with paragraph 344.7 (a), (b), (c), (d), and (g) and passes with 100 % radiographic examination in accordance with paragraph 344.5 or 100 % ultrasonic examination in accordance with paragraph 344.6 provides adequate assurance that the weld is reliable and leak tight. The change continues to provide adequate safety since it requires that all piping closure welds that are not leak tested are in-process examined and 100 % volumetrically examined which exceeds the requirements of ASME B31.3 for closure welds that are leak tested. The inability to leak test these closure welds hydrostatically or pneumatically does not affect the soundness of the welds.

Exception to B31.3 Paragraph 302.2.4

HPAV analysis and design criteria are provided in Appendix C of the Basis of Design, 24590-WTP-DB-ENG-18-001. The engineering methods and criteria of Appendix C are based on testing and analysis summarized in HPAV Piping Methodology and Criteria, 24590-WTP-RPT-ENG-07-011. That report is a detailed summary of the testing and calculations accomplished to develop HPAV analysis methods and acceptance criteria. The HPAV analysis methods and acceptance criteria are limited to 4 inch and less nominal pipe size (NPS).

The specific exception will be taken to B31.3 paragraph 302.2.4(e) for detonation, deflagration-to-detonation transition (DDT), and reflected deflagration-to-detonation transition (R-DDT) events. This paragraph does not permit pressures that exceed the test pressure. The design rules provided in Appendix C of the Basis of Design, 24590-WTP-DB-ENG-18-001 for these events will ensure that the system will maintain pressure boundary even if the event pressure allowed by the exception exceeds the test pressure.

Justification: ASME B31.3 does not address highly impulsive pressure loading and does permit the designer to perform detailed analysis for unusual situations, as indicated in Paragraphs 300(c)(3) and 304.7.2 for Unlisted Components. The design rules in Appendix C of the Basis of Design, 24590-WTP-DB-ENG-18-001, ensure that the piping system will maintain pressure boundary under all detonation, deflagration to detonation transition (DDT), or reflected DDT (RDDT) conditions.

C.10 DOE-STD-1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities (Applicable to HLW Facility)

Revision: Change Notice #1 dated 1/96 and DOE Newsletter dated 1/22/98 (Interim Advisory on Straight Winds and Tornados)

Sponsoring Organization: DOE

HLW Facility Specific Tailoring

The following tailoring of DOE-STD-1020-94 is required for use by the HLW Facility.

All Pages

Replace reference of:

Use 1997 UBC in lieu of 1994 UBC

Use ASCE 4-98 in lieu of ASCE 4-86 Table 6

Justification: Utilization of more recent edition

Page 1-7, Section 1.4 Quality Assurance and Peer Review

Section 1.4 requires Independent Peer Review for PC-2, PC-3, and PC-4 SSCs. Early on, the DFHLW Project designated certain CM, SC-IV SSCs as CM, SC-III, or CM, SC-II, in order to eliminate any seismic interactions that would result due to a CM, SC-IV, source that could possibly interact with a Q, SC-III, or a Q, SC-I, target. This approach does not upgrade the source from PC-0 or PC-1 to PC-2 or PC-3, and an Independent Peer review of the CM, SC-III or CM, SC-II SSC design is not required.

Justification: This is a clarification, and is consistent with the Commentary to DOE-STD-1020, Section C.6.2, “Seismic Interaction,” which states:

> *If there is potential interaction, the source does not move to the performance category of the target but remains in its own category based on its own characteristics.*

Choosing to use the SC-III (or SC-II) seismic demand was simply a prudent method for acquiring CM SC-IV SSCs early in the Project; there was no intent to upgrade these items to PC-2 or PC-3, which is consistent with both the cited Commentary and Section 4.1-3 of the Safety Requirements Document.

Page 2-1, Section 2.2 General Approach for Seismic Design and Evaluation

Use 1997 UBC in lieu of 1994 UBC.

Justification: 1997 UBC is more current.

Note that the following text and discussion also apply to Sections 2.3.2, 2.5, and C.4.4

Design PC-3 (Seismic Category I) SSCs for the elastic seismic response to DBE with no credit for inelastic energy absorption. However, the following SSCs may use inelastic energy absorption factors greater than 1.0 for seismic response in the design of the SSC:

- SC-I SSCs (except piping, piping components and pipe supports) constructed and/or fabricated prior to the revised seismic criteria, April 4, 2005.
- For SC-I and II piping, piping components, pipe supports and conduit, regardless of construction or fabrication status. F_μ values shall be in accordance with the table below (ASCE 43-05, Table 8-1, LS B). However, for piping and pipe support components that exhibit non-ductile failure modes (buckling, concrete expansion anchor pull out, cast-iron standard components), for components where small deformations can result in leakage (flange joints and Purex connectors), and for predicting active equipment loads and accelerations, F_μ shall be limited to 1.0.

HLW Facility Pipe Stress Analysis and Support Design Inelastic Energy Absorption Factor, F_μ

Component	Factor, F_μ[1]
Butt joined groove welded pipe	1.50
Socket welded pipe	1.25
Threaded pipe	1.15
Equipment and Pipe Supports	1.50

[1]ASCE 43-05, Limit State B Distribution Systems.

Justification: DOE-STD-1020-94 allows credit for inelastic energy absorption in the design of PC-3 SSCs. The requirements for PC-3 (SC-I) SSCs remain more stringent and conservative than the requirements of DOE-STD-1020-94. DOE-STD-1020-94 does not provide specific F_μ factors for use in piping system analysis. The ASME B31.3 stress allowable (1.33S for occasional loads) combined with F_μ factors applicable to Limit State B of ASCE 43-05 provide adequate design margin for HLW Facility SC-I and SC-II piping. It is more stringent compared to the ASCE 43-05 requirement of designing to ASME Section III Level D allowable stresses (3S, $2S_y$) permitted for LS A/B ($1.33*1.5$ (max F_u) $= 2.0 < 3S$).

Page 2-6, Section 2.3 Seismic Design and Evaluation of Structures, Systems, and Components

SC/SS SSCs:

Perform performance categorization of SSCs per Section 2.4 of DOE-STD-1021-93 as described in Section 4.4 and Appendix D of the BOD.

Justification: For SC/SS SSCs, DOE-STD-1021-93 is directly linked to DOE Order 420.1B, which is invoked by 10 CFR 830 as the source of nuclear safety design criteria.

Page 2-12, Section 2.3.2 Performance Category 3 and 4 Structures, Systems, and Components

Disregard the requirements for PC-4 SSCs.

Justification: There are no PC-4 SSCs at the WTP.

Use ACI 349 for design of reinforced concrete in lieu of UBC. For seismic detailing of concrete, use ACI 318-1999, Chapter 21.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Use ANSI/AISC N690 for design of structural steel for PC-3. For seismic detailing of structural steel, UBC-1997 Section 2213.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Page 2-18, Section 2.4.1 Equipment and Distribution Systems

Perform seismic design of PC-1 and -2 elements of structures and equipment per the provisions of 1997 UBC in lieu of 1994 UBC.

Justification: 1997 UBC is more current.

Page 2-20, Section 2.4.1 Evaluation of Testing

For testing of PC-3 SSCs, use requirements from IEC/IEEE 60980-344 (Ref. 2-11).

For testing PC-2 (or lower) SSCs, use IEC/IEEE 60980-344 or AC 156 (Ref. 2-25).

Justification: The guidance for testing of SS SSCs need not be restricted to only IEC/IEEE 60980-344 standard. As discussed on Page 2-4 of this standard, Performance Category 2 and lower SSCs may employ the Uniform Building Code (UBC) provisions for seismic design and evaluation criteria.

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Page 2-24, Section 2.5 Summary of Seismic Provisions

Disregard the requirements for PC-4 SSCs.

Justification: There are no PC-4 SSCs at the WTP.

Page 2-25, Section 2.6 References

Ref. 2-11. IEC/IEEE 60680-344, International Standard, Nuclear Facilities – Equipment Important to Safety – Seismic Qualification.

Justification: Updating the referenced standard as IEEE-344 is superseded by IEC/IEEE 60980-344.

Page 2-26, Section 2.6 References

Ref. 2-25. AC156 Acceptance Criteria for Seismic Qualification Testing of Nonstructural Components, January 2000. ICBO Evaluation Service, Whittier, California.

Justification: Adding a referenced standard to the list of references for this section of DOE-STD-1020.

Page 3-1, Section 3.1 Introduction

SC/SS SSCs:

Perform performance categorization of SSCs per Section 2.4 of DOE-STD-1021-93 as described in Appendix D of the BOD.

Justification: For SC/SS SSCs, DOE-STD-1021-93 is directly linked to DOE Order 420.1B, which is invoked by 10 CFR 830 as the source of nuclear safety design criteria.

Page 3-2, Section 3.2 Wind Design Criteria

Use wind speed values identified in HLW Facility BOD Section 4.

Justification: The report HNF-SD-GN-ER-501 Rev. 2 was added to the WTP contract and was used to develop the values in Section 4 of the HLW Facility BOD.

Page 3-5, Section 3.2.1 Performance Category 1

Design structural steel PC-1 structures per AISC Manual of Steel Construction, Allowable Stress Design, Ninth edition.

Justification: The AISC code is preferred to the UBC because it is a national consensus code.

Design reinforced concrete PC1 structures per ACI 318-99.

Justification: The ACI 318 code is preferred to the UBC because it is a national consensus code.

Page 3-6, Section 3.2.2 Performance Category 2

Design structural steel PC-2 structures per AISC Manual of Steel Construction, Allowable Stress Design, Ninth edition.

Justification: The AISC code is preferred to the UBC because it is a national consensus code.

Design reinforced concrete PC2 structures per ACI 318-99.

Justification: The ACI 318 code is preferred to the UBC because it is a national consensus code.

Page 3-6, Section 3.2.3 Performance Category 3

Design structural steel PC3 structures per ANSI/AISC N690-94.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Design reinforced concrete PC3 structures per ACI 349-2001.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Disregard requirements for tornado design.

Justification: Tornados are not a design consideration at Hanford compared to the straight wind hazard per HNF-SD-GN-ER-501 Rev 1 Section 3.2.

Page 4-1, Section 4.0 Flood Design and Evaluation Criteria

Disregard criteria for the design of SSCs for river flooding.

Justification: River flooding is not a credible NPH at the WTP site as cited in PNNL-26204, and only the criteria dealing with local precipitation that affects roof design and site drainage are applicable to the WTP design.

Page 4-4, Section 4.1.2 Flood Evaluation Process

SC/SS SSCs:

Perform performance categorization of SSCs per Section 2.4 of DOE-STD-1021-93 as described in in Section 4.5 of the BOD.

Justification: For SC/SS SSCs, DOE-STD-1021-93 is directly linked to DOE Order 420.1B, which is invoked by 10 CFR 830 as the source of nuclear safety design criteria.

Page 4-16, Section 4.5 Probabilistic Flood Risk Assessment

Do not perform a probabilistic flood risk assessment of the WTP site.

Justification: UCRL-21069, "Probabilistic Flood Hazard Assessment for the N Reactor, Hanford, Washington", July 1988, contains a probabilistic flood risk assessment of the N reactor site. The WTP site is close to the N Reactor site (about 10 miles away) and further away from the Columbia River. Therefore, the N Reactor flood assessment may be used and no assessment of the WTP site is required.

Page B-4, App. B, Section B.2 Graded Approach, Performance Goals, and Performance Categories

Page C-1, App. C, Section C.1 Introduction

SC/SS SSCs:

Perform performance categorization of SSCs per Section 2.4 of DOE-STD-1021-93 as described in BOD.

Justification: For SC/SS SSCs, DOE-STD-1021-93 is directly linked to DOE Order 420.1B, which is invoked by 10 CFR 830 as the source of nuclear safety design criteria.

Page C-19, App. C, Section C.3.2 Earthquake Ground Motion Response Spectra

Disregard Section C.3.2.1 discussion and Table C-4. Follow 1997 UBC for the HLW Facility design.

Justification: Section C.3.2.1 discussion and Table C4 are based on 1994 UBC; the 1997 UBC is more current.

Page C-52, App. C, Section C.5.1 Capacity Approach

Use ACI 349 for design of reinforced concrete in lieu of UBC.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Use ANSI/AISC N690 for design of structural steel in lieu of UBC.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

Page C-66, App. C, Section C.9 Alternate Seismic Mitigation Measures

Delete this section.

Justification: Seismic base isolation is not planned to be used in the HLW Facility design.

Page D-3, App. D, Section D.3 Load Combinations

Design structural steel PC-1 and PC-2 structures per AISC Manual of Steel Construction, Allowable Stress Design, Ninth edition.

Justification: The AISC code is preferred because it is a national consensus code.

Design reinforced concrete PC1 and PC2 structures per ACI 318-99.

Justification: The ACI 318 code is preferred because it is a national consensus code.

Design structural steel PC3 SSCs structures per ANSI/AISC N690-94.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2..

Design reinforced concrete PC3 SSCs structures per ACI 349-2001.

Justification: This tailoring is consistent with codes and standards called out in DOE Order 420.1C Change 3. It was originally implemented for consistency with NRC acceptance criteria contained in Section 3.8.4 of NUREG-0800, Revision 2.

C.11 DOE-STD-1020-16, Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities (Applicable to HLW Support Facilities)

Revision: 2016

Sponsoring Organization: DOE

HLW Support Facilities Specific Tailoring

The following tailoring of DOE-STD-1020-16 is required for use by the DFHLW Project.

In 2023, BNI conducted an evaluation between DOE-STD-1020-1994 and the 2016 version. The evaluation reviewed the seismic design for the HLW Facility, considering changes made to the seismic design-related codes and standards over more than two decades. The evaluation confirmed that the analysis and design remain valid. The conservatism adopted in seismic input motion, method of seismic analysis and processing of seismic responses for design clearly show a sizable margin as shown in computed demand and capacity ratios of key walls and slabs in the HLW Facility.

Similarly, the evaluation determined that the in-structure response spectra developed for design and qualification of equipment within the HLW structure were conservative particularly considering the reduction of seismic input motion from the previously used design response spectra compared to the most updated seismic hazard analysis at the Hanford site. The evaluation also reviewed the current design for volcanic eruption and volcanic ash loading. The evaluation determined that the return periods and ashfall loads were consistent and remained conservative.

The recommendation from the evaluation is to use DOE-STD-1020 1994 version for completed and future work for the HLW Facility (building 30) with minor modifications to the current tailoring. In addition, for all new facilities (e.g., Melter assembly and RWH building add-on, and new facilities) will follow the 2016 edition of DOE-STD-1020 with minor tailoring.

Throughout the standard, replace the following codes with later version as follows:

Change ANSI/ANS-2.26-2004 (R2010) to ANSI/ANS-2.26-2004 (R2021).

Change ANSI/ANS-2.27-2008 to ANSI/ANS-2.27-2020.

Change ANSI/ANS-2.29-2008 to ANSI/ANS-2.29-2020.

Change ANSI/AISC N690-12 to ANSI/AISC N690-18.

Change ASCE 4-98 to ASCE/SEI 4-16.

Change ASCE/SEI 7-10 to ASCE/SEI 7-22.

Change ASCE/SEI 43-05 to ASCE/SEI 43-19.

Change IBC-2015 to IBC 2021.

Change ACI 349-06 to ACI 349-13

Change ANSI/ANS-2.3-2011 (R2011) to ANSI/ANS-2.3-2011 (R2021).

Change ANSI/ANS-3.11-2015 to ANSI/ANS-3.11-2015 (R2020).

Change ANSI/AISC N690-06 to ANSI/AISC N690-18.

Justification: Update building codes to the latest version.

Page 11; Section 3.2.1

Change "(Table 1-2)" to "(Table 1-1)".

Justification: Table 1-1 of ASCE 43-19 corresponds to Table1-2 of ASCE 43-05 cited in DOE-STD-1020.

C.12 DOE-STD-1195 (2011), Design of Safety Significant Safety Instrumented Systems Used at DOE Non-Reactor Facilities

Revision: April 2011

Sponsoring Organization: Department of Energy.

HLW Facility Specific Tailoring

General

This standard is applied to Safety Significant Safety Instrumented Systems in the HLW Facility.

Justification: Based on DOE direction in CCN 310146 (HLW) and DOE O 420.1C Change 3

Replace ANSI/ISA 84.00.01-2004 with ANSI/ISA 61511-1-2018 throughout.

Justification: ANSI/ISA 84.00.01-2004 has been withdrawn and replaced by ANSI/ISA 61511-1-2018. ANSI/ISA 61511 provides updated requirements for application programming (software), functional safety assessments, management of change, security risk assessments, hardware fault tolerance and use of non-safety control systems as a protection layer. The WTP Project has adopted ANSI/ISA 61511-1-2018 into the HLW Facility code of record.

Section 1.1 Scope

Delete second paragraph, final sentence wording: "In addition, recognized national and consensus standards as well as Nuclear Regulatory Commission's regulatory guides, should also be consulted as appropriate".

Justification: The applicability of the DOE and national consensus standards has been examined and the specific references to be applied are identified in the tailoring of Appendix H. The existing DFHLW Project approaches based on DOE and process industry approaches are judged adequate.

Section 1.2 Applicability

Delete first paragraph and replace with:

"This standard is applied to Safety Significant instrumented functions identified and documented in the Preliminary Documented Safety Analysis (PDSA) or Documented Safety Analysis (DSA)."

Justification: Only the PDSA / DSA are used to identify Safety Requirements on the project. This standard only applies to safety functions using instrumentation.

Section 2.7, Human Factors Engineering

First paragraph final sentence.

Replace: "An HFE Plan should be developed for the SS SIS, defining the required participants and human factors activities, including the documentation, review, and approval of each activity."

With "A human factors plan should include human factors reviews of designs related to the operational and maintenance interfaces for the safety instrumented functions"

Justification: There is no requirement in ANSI/ISA 61511-1-2018 for a separate HFE (human factors evaluation) plan for the safety systems. The requirements for safety instrumentation and systems can be embedded within an overall HFE Plan.

Second Paragraph:

Delete ANSI/ISA 18.2, *Management of Alarm Systems for the Process Industries*

Justification: The HLW Facility currently applies an alarm categorization scheme, based on section 11.12.4.3 of 24590-WTP-RPT-OP-01-001, *Operations Requirements Document*. ANSI/ISA 18.2 is not in the HLW Facility code of record.

Section 2.8, Security

Final paragraph final sentence. Delete "Users should consult applicable DOE requirements and other industry standards to ensure the design meets the security requirements."

Justification: HLW Facility is contracted to DOE O 205.1B *DOE Cyber Security Program.* Also, ANSI/ISA 61511-1-2018, includes requirements for a security risk assessment (8.2.4), requires the design to be resilient against identified security risks (11.2.12), basic access security associated with the operator interface (11.7.2.5) and maintenance/engineering interface (11.7.2.2).

Appendix B, Section B.2, Page B-2

Final Sentence: "Selection of IPL's and justification for SIL determination for an SS SIS shall be documented in the DSA" to be replaced with:

"The PDSA/DSA will include information related to the SIL determination, including a discussion of Independent Protection Layers (IPLs) relied upon."

Justification: The selection and justification does not have to go in the DSA, it is optional.

Appendix H, Applicable Documents

Replace Appendix H with the following lists of references:

<u>H.1 Department of Energy Directives</u>

- DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*

Note: This guidance is already included and addressed through 24590-WTP-QAM-QA-06-001, *Engineering, Procurement, and Construction Quality Assurance Manual*

- DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide For Use With DOE O 420.1, Facility Safety*

Note: This guidance is associated with safety analysis and does not directly impact control and instrumentation designs.

- DOE O 414.1D Chg 2, *Quality Assurance*
- DOE O 420.1C, Change 3*, Facility Safety*
- DOE-STD-1186-2016, *Specific Administrative Controls.*

- DOE-STD-1189-2016, *Integration of Safety into the Design Process*
- DOE-STD-3007-2017, *Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities.*
- DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Documented Safety Analyses.*

H.2. National and International Standards

- ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications* as defined in the quality assurance plan.
- ANSI/ANS 58.8, *Time Response Design Criteria for Safety-Related Operator Actions.*
- ANSI/IEEE-Std-500, *IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear Power Generating Stations.*

Note: This standard is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. The standard is applied as a possible source of reliability data as described in DOE-STD-1195 (2011) Appendix E Section E.1.1.

- ANSI/IEEE-Std-1023, *Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities.*
- ANSI/ISA 67.04.01, *Setpoints for Nuclear Safety-Related Instrumentation.*
- ANSI/ISA 61511-1-2018 *Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, definitions, system, hardware, and application programming requirements.* (Published after the issuance of DOE-STD-1195-2011)

The following references are updated to align with the tailoring that changes ANSI/ISA 84.00.01-2004 (superseded by IEC 61511-1-2018) to ISA 61511-1-2018 (Published after the issuance of DOE-STD-1195-2011). They are listed in Section H.2 "National and International Standards" in DOE-STD-1195 and are not mandatory. They provide added guidance to support the standard and are intended to be used as appropriate to the HLW Facility safety instrumented system designs:

- o ANSI/ISA 61511-2-2018, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 2: Guidelines for the Application of IEC 61511-1:2016 (IEC 61511-2:2016, IDT1 Mod)*
- o ANSI/ISA 61511-3-2018, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 3: Guidance for the determination of the required safety integrity levels (IEC 61511-2:2016, IDT).*
- o ISA TR84.00.02*, Safety Instrumented Functions (SIF) – Safety Integrity Level (SIL) Verification of Safety Instrumented Functions*
- o ISA TR84.00.03, *Automation Asset integrity of Safety instrumented Systems (SIS)*
- o ISA TR84.00.04, *Guideline for the Implementation of ANSI/ISA*-61511-1:2018

H3. Nuclear Regulatory Commission (NRC) Guidance

- NUREG-0700, Rev. 2, Human-System Interface Design Review Guidelines

Justification: The other standards and references do not need to be applied to the HLW Facility designs. Rationale and justification for the exclusions of each reference included in Appendix H of DOE-STD- 1195 is provided below:

H.1 Department of Energy Directives:

(note: not all the listed items in DOE-STD-1195 (2011) are directives, some are guidance documents)

DOE-HDBK-1140-2001, *Human Factor/Ergonomics Handbook for the Design for Ease of Maintenance.*

Not applicable. The guidance in this handbook includes labelling and human factors principles. Main elements are already addressed in the DFHLW Project and NUREG-0700 approaches. As stated in 24590-WTP-PD-RAEN-EN-0010, *Human Factors Program Description*, the DFHLW Project follows guidance from IEEE 1023 and NRC in NUREG-0700, for the DFHLW Project human factors program.

DOE O 426.1 *Federal Technical Capability*.

This order applies to the DOE organization and as such is outside the scope of the WTP.

DOE O 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities.*

This order is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities and does not directly impact the safety instrumentation designs and implementation.

H.2 National and International Standards

ANSI/ANS 8.3, *Criticality Accident Alarm Systems*.

Not applicable. This standard is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. The HLW Facility has no requirements for criticality alarm systems, at current time. Criticality issues are being re-examined and if warranted this would be added to the contract requirements and code of record.

ANSI/IEEE standard related to software:

ANSI/IEEE-Std-730, *Standard for Software Quality Assurance Plans*

ANSI/IEEE-Std-828, *Standard for Software Configuration Management Plans*

ANSI/IEEE-Std-829, *Standard for Software Test Documentation*

ANSI/IEEE-Std-830, *Recommended Practice for Software Requirements Specifications*

ANSI/IEEE-Std-1012, *Standard for Software Verification and Validation*

ANSI/IEEE-Std-1028, *Standard for Software Reviews and Audits*

ANSI/IEEE-Std-1074, *Standard for Developing Software Life-Cycle Processes*

ANSI/IEEE-Std-1219, *Standard for Software Maintenance*

ANSI/IEEE-Std-1228, *Standard for Software Safety Plans*

Not applicable. The DFHLW Project Software processes and procedures follow the requirements of 24590-WTP-QAM-QA-06-001, *Quality Assurance Manual* and DOE O 414.1C. *Quality Assurance*. DOE-STD-1195 (2011) Section 2.2 and Appendix F, section F.3 allow applications to use standards other than DOE O 414.1C provided the basis for the selection is documented and shown to be equivalent to DOE O 414.1C. Since the DFHLW Project is already applying DOE O 414.1C no such evaluation is necessary and the other standards and references including the ANSI/IEEE standards listed above add no value and do not need to be applied.

ANSI/ISA 67.01.01, *Transducer/Transmitter Installation for Nuclear Safety Applications.*

Not applicable. This standard is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. Appropriate requirements are already included in project installation practices.

ANSI/ISA 18.2, *Management of Alarm Systems for the Process Industries*.

See justification for exclusion against section 2.7 earlier in this Appendix.

IEC 61508, *Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.*

This international standard is targeted at Supplier's and is not applied directly to the HLW Facility. Based on the approaches in DOE-STD-1195 (2011) (Appendix E) industry databases and a reliability monitoring program may be used to confirm reliability needs are met. The DFHLW Project may use vendor information including IEC 61508 certification, or compliance documents if available to support the reliability analysis, but the standard is not mandatory.

IEC 61511, *Functional Safety – Safety Instrumented Systems for the Process Industry Sector.*

Not applicable. This is the international version of ANSI/ISA 61511, which is applied to the HLW Facility.

IEEE-Std-845, *IEEE Guide to Evaluation of Man-Machine Performance in Nuclear Power Generation Station Control Room and Other Peripheries*

Not applicable. This is a guide for evaluations. As stated in 24590-WTP-PD-RAEN-EN-0010, *Human Factors Program Description*, the DFHLW Project follows guidance from IEEE 1023 and NUREG-0700, for the basis for the DFHLW Project human factors program. Standard does not directly impact control and instrumentation designs.

IEEE-Std. 7-4.3.2, *Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations*

Not applicable. This is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. This standard covers safety needs plus specifics related to software and hardware. The standard is inter-dependent with, and references IEEE-603 in several places. IEEE-603 is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities for safety instrumentation design. IEEE-603 as tailored is applied to electrical design aspects. The DFHLW Project adopted the process industry practices permitted by DOE-STD-1195 (2011) rather than nuclear reactor standards, for safety instrumentation designs. These address the necessary hardware requirements and design aspects. The DFHLW Project software processes, requirements and procedures follow the requirements of 24590-WTP-QAM-QA-06-001, *Quality Assurance Manual* and DOE O 414.1C. *Quality Assurance.*

ISA TR84.00.06, *Safety Fieldbus Design Considerations for Process Industry Sector Applications*

Not applicable. Fieldbus is not used for safety instrumentation at the HLW Facility.

H3. Nuclear Regulatory Commission (NRC) Guidance

NUREG-0711, *Human Factors Engineering Program Review Model*

Not applicable. This review model is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. As stated in 24590-WTP-PD-RAEN-EN-0010, *Human Factors Program Description*, the DFHLW Project follows guidance from IEEE 1023 and NUREG-0700, for the basis for the DFHLW Project human factors program.

For the following group of standards:

NUREG-0800, *BTP 7-14, Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems*

NUREG-0800, BTP 7-18, *Guidance on the Use of Programmable Logic Controllers in Digital Computer-Based Instrumentation and Control Systems*

NUREG-0800, BTP 7-19, *Guidance for Evaluation of Diversity and DID in Digital Computer-Based Instrumentation and Control Systems*

NUREG-0800, BTP 7-21, *Guidance on Digital Computer Real-time Performance*

NUREG-6090, *The PLC and its Application in Nuclear Reactor Protection Systems*

NUREG-6303, *Method for Performing Diversity and Defense-in-Depth Analyses of Reactor Protection Systems*

NUREG/CR-6421, *A Proposed Acceptance Process for Commercial Off-the–Shelf (COTS) Software in Reactor Applications*

NUREG/CR-6842, *Advanced Reactor Licensing: Experience with Digital I&C Technology in Evolutionary Plants*

NRC RG 1.152, Rev. 2, *Criteria for Use of Computers in Safety Systems of Nuclear Power Plants*

Not applicable. Justification is as provided for ANSI software standards and IEEE 603, the DFHLW Project follows the DOE approaches for software and process industry standards (DOE-STD-1195-2011 and ANSI/ISA 61511-1-2018) for instrumentation including hardware and computer systems used in safety applications.

H4. Other

EPRI-1008122, *Human Factors Guidance for Control Room and Digital Human-System Interface Design and Modification: Guidelines for Planning, Specification, Design, Licensing, Implementation, Training, Operation, and Maintenance*.

Not applicable. As stated in 24590-WTP-PD-RAEN-EN-0010, *Human Factors Program Description*, the DFHLW Project follows guidance from IEEE 1023 and NUREG-0700. The EPRI-1008122 guidance is a total of 1136 page and cross references many other references. The main aspects needed appear already addressed in the DFHLW Project approaches.

EPRI TR-102260, *Supplemental Guidance for the Application of EPRI Report NP-5652 on the Utilization of Commercial Grade Items and EPRI TR-106439, Guideline on Evaluation and Acceptance of Commercial Grade Digital Equipment for Nuclear Safety Applications*

Guidance not applicable. This is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. Judged not appropriate to be applied on the DFHLW Project.

INPO 05-003, P*erformance Objectives and Criteria – Fundamentals of Training*

Not applicable. This is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. Judged not appropriate to be applied on the DFHLW Project.

MIL-STD-1472*, Department of Defense Design Criteria Standard – Human Engineering*

Not applicable. This is not part of the Engineering, Procurement, and Construction (EPC) Code of Record for the High-Level Waste (HLW) Facility and DFHLW Supporting Facilities. As stated in 24590-WTP-PD-RAEN-EN-0010, *Human Factors Program Description*, the DFHLW Project follows guidance from IEEE 1023 and NUREG-0700, for the basis for the DFHLW Project human factors program.

C.13 IBC 2021

Revision: 2021

Sponsoring Organization: International Code Council

DFHLW Project Specific Tailoring

The following tailoring of IBC-2021 is required for use by the DFHLW Project:

Section 1608.2 Ground Snow Loads

Revise Section 1608.2 to: The ground snow loads to be used in determining the design snow loads for roofs shall be determined in accordance with ASCE 7. Snow loads are zero for Hawaii, except in mountainous regions as approved by the building official.

Justification: The latest revision to ASCE 7-22 has updated the snow load database and figures, the figures in IBC are not current.

Chapter 13 Energy Efficiency

The IBC Chapter 13 – Energy efficiency, shall be replaced by the tailored version of ASHRAE 90.1, Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.

Justification: International Energy Conservation code is equivalent to ASHRAE 90.1.

C.14 Implementation of IEEE Standards

The following applies to all of the IEEE standards specified in the DFHLW Project COR.

Table C-1 IEEE SS/SC Applicability From DOE O 420.1C Change 3

Specifies the minimum applicability/utilization of IEEE codes for safety class and safety significant SSCs

Code	Applicable to SC Table 5 of DOE O 420.1C, Change 3 Note 1	Applicable to SS Table 5 of DOE O 420.1C, Change 3 Note 1	Guidance Applicable to SS & SC Table 6 of DOE O 420.1C, Change 3 Note 2
IEEE 308-2020	Y	N	N
IEC/IEEE 60780-323-2016	Y	N	Y
IEEE 384-2018	Y	N	N
IEEE 387-2017	N	N	Y
IEEE 603-2018	N	N	Y
IEEE 628-2020	N	N	Y
IEEE 338-2012	Y	N	N
IEEE 379-2014	Y	N	N
IEEE C37-2010	Y	Y	N

Note 1: DOE O 420.1C, Change 3, specifies the minimum applicability/utilization of IEEE codes for safety class and safety significant SSCs. The list above is not exhaustive and only includes items that are tailored – see DOE O 420.1C Change 3 for required utilization. The safety analysis may invoke additional standards above as required e.g., IEEE 384 for physical and electrical separation methods for SS SSCs.

The Project does not plan on having safety class SSCs. Additional tailoring maybe required should safety class be required or if the standards in the table above are applied by nuclear safety.

Note 2: The guidance standards are used as non-mandatory requirements.

When applicable, standards listed in Table C-1 are implemented in the design of SS SSCs.

When the references listed below are cited in the standards in Table C-1, note that the versions listed below apply and that they are tailored for use on the DFHLW Project as shown:

- ASME NQA-1 as specified by the quality assurance manual
- DOE-STD-1195 (2011) (as tailored)
- ANSI/ISA 61511-1-2018 (as tailored)
- ANSI/ISA 67.04.01-2018 (as tailored)
- NFPA-801-2020
- IEEE 308-2020 (as tailored)
- IEC/IEEE 60780-323-2016
- IEC/IEEE 60980-344

- IEEE 338-2012 (as tailored)
- IEEE 379-2014 (as tailored)
- IEEE 384-2018 (as tailored)
- IEEE 387-2017 (as tailored)
- IEEE 603-2018 (as tailored)
- IEEE 628-2020
- IEEE 1187-2013
- IEEE 1188-2005
- IEEE C37-2010

For the standards in Table C-1, design of Safety Instrumented Systems instrumentation and controls is implemented as follows:

For Safety Class

ANSI/ISA 61511-1 (2018) Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, definitions, system, hardware, and application programming, as tailored.

For Safety Significant

DOE-STD-1195 (2011), *Design of Safety Significant Safety Instrumented Systems Used at DOE Non-Reactor Nuclear Facilities,* as tailored.

ANSI/ISA 61511-1 (2018) *Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, definitions, system, hardware, and application programming,* as tailored.

Justification: For Safety Class functions, the DFHLW Project has adopted process industry practices supplemented by tailored IEEE standards 379 and 384. For Safety Significant functions, the DFHLW Project has adopted process industry practices permitted by DOE-STD-1195 (2011) rather than nuclear reactor standards.

Use version ANSI/ISA 67.04.01-2018 *Setpoints for Nuclear Safety-Related Instrumentation* (as tailored).

Justification: The standard ISA-67.04.01-2018 (as tailored) is required for use by the DFHLW Project as an implementing standard for SC and SS control system design).

The IEEE standards use language and definitions that are specific to Nuclear Power Generating stations. Application of the definitions is read to replace accidents discussed as accidents identified by the nuclear safety analysis for the HLW Facility.

C.15 IEEE-384, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits

Revision: 2018

DFHLW Project Specific Tailoring

The following tailoring of IEEE-384 is required for use by the DFHLW Project as an implementing standard for Safety Systems, electrical equipment, and circuit design.

All Sections Clarification of Nuclear Power Generating Station Terminology

The term "Standby Generator" in the Standard is synonymous with "Emergency Generator" in the HLW Facility.

Justification: As determined, the Standby Generators on the DFHLW Project are not classified as SC or SS while the Emergency Generators are classified as SC or SS.

Section 2.0 Normative References

- ANSI/NFPA 803, Fire Protection for Light Water Nuclear Power Plants.

Justification: This document specifically addresses nuclear power generating stations. Per the DFHLW Project COR, the DFHLW Project will use NFPA 801-2020 as an implementing standard for fire protection,

Section 4.3 Equipment and Circuits Requiring Independence

Replace

> Equipment and circuits requiring independence shall be determined and delineated during the plant design and shall be identified on documents and drawings in a distinctive manner. (See IEEE Std 603 for guidance on identification.)

with the following:

> Equipment and circuits requiring independence shall be determined during the NSE safety analysis process review cycle and plant design and identified on documents and drawings in a distinctive manner.

Justification: The NSE safety analysis process will provide reliability requirements for each control strategy. These reliability requirements determine when control strategies require independence, redundancy, and seismic qualifications.

C.16 ANSI/ISA-61511-1-2018 Functional Safety: Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, definitions, system, hardware, and application programming requirements.

Revision: 2018, Approved 11 July 2018

Sponsoring Organization: American National Standards Institute/ Instrument Society of America

WTP Project Specific Tailoring

The following tailoring of ANSI/ISA-61511-1-2018 is required for use by the DFHLW Project.

General
The standard is applied and modified by the tailored version of DOE-STD-1195 (2011) to Safety Significant instrumentation on the DFHLW Project.

Justification: Based on DOE direction in CCN 310146 (HLW Facility). Note: The tailored version of DOE-STD-1195 (2011) does not explicitly reference many of the sections and clauses of ANSI/ISA-61511-1-2018.

This document has been digitally signed using the Electrosign process.

Document for Signature

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