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Ms. Smith:

SUBMITTAL OF HIGH-LEVEL WASTE FACILITY AND LOW-ACTIVITY WASTE FACILITY SYSTEM DESIGN DESCRIPTION DOCUMENTS

Reference: WA7890008967, "Dangerous Waste Portion of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Operating Unit 10, 'Waste Treatment and Immobilization Plant.'"

This letter transmits the following updated system design descriptions for inclusion in the Administrative Record:

- *HLW Melter Feed Process (HFP) and Concentrate Receipt Process (HCP) System Design Description*, 24590-HLW-3ZD-HFP-00001, Rev. 0 (Attachment 1)
- *HLW Radioactive Liquid Waste Disposal System (RLD) Design Description*, 24590-HLW-3ZD-RLD-00001, Rev. 0 (Attachment 2)
- *LAW Primary Offgas (LOP) and Secondary Offgas/Vessel Vent (LVP) System Design Description*, 24590-LAW-3ZD-LOP-00001, Rev. 0 (Attachment 3)

These system design descriptions are being submitted to Washington State Department of Ecology to replace earlier versions of system descriptions that were incorporated into the Dangerous Waste Permit Administrative Record.

If you have any questions, please contact Gae M. Neath, Environmental Compliance Division, (509) 376-7828.

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Attachment 1
16-ECD-0048
(175 Pages Excluding Cover Sheet)

HLW Melter Feed Process (HFP) and Concentrate Receipt Process (HCP) System Design Description

24590-HLW-3ZD-HFP-00001

Issued by
RPP-WTP PDC

HLW Melter Feed Process (HFP) and Concentrate Receipt Process (HCP) System Design Description

Document title: HLW Melter Feed Process (HFP) and Concentrate Receipt Process (HCP) System Design Description

Document number: 24590-HLW-3ZD-HFP-00001

Revision number: 0

Type:
- ☑ System Design Description
- ☐ Facility Design Description

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Validation

Appl.	Requirement Area	Requirement Developer	Signature	Date
☐	Architectural Design			
☐	Civil/Structural Design			
☑	Controls & Instrumentation Design	Wayne Underhill	See attached email	6/13/16
☐	Electrical Design & AHJ			
☐	Fire Protection Engineering			
☐	HVAC Design			
☑	Mechanical Handling Design	Julian Leam	See attached email	6/13/16
☑	Mechanical Systems Design	Julian Leam	See attached email	6/13/16
☑	Plant Design	John Schuette	See attached email	6/13/16
☑	Process Engineering	Eric Slaathaug	See attached email	6/13/16
☐	Interface (External)			
☐	Interface (Internal)			
☒	System Functions and Requirements	Jason Appleby	[illegible]	6/13/16
☑	Equipment Environmental Qualification	Govind Rajagopal	See attached email	6/13/16
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☐	Plant Software Design			
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☑	Nuclear Safety Engineering	Scott Manley	See attached email	6/13/16
☐	Criticality Safety			
☑	Radiological Engineering	Kyle Peltier	See attached email	6/13/16
☐	Industrial Safety/Hygiene (ESH)			
☐	Mission (WTP Contract functional/ performance rqmts)			
☑	Operations Requirements Document (Plant Ops)	Dan Rovira	See attached email	6/13/16
☑	Quality Assurance	Virginia Cleary-Turnoff	See attached email	6/13/16
☐	Safeguards & Security			
☐	Startup			
☐	Transportation & Logistics			

* Validation not required for alpha/preliminary design description documents.

History Sheet

Rev	Reason for revision	Revised by
A	Initial issue. Replaces 24590-HLW-3YD-HFP-00001, *System Description for HLW Concentrate Receipt Process and HLW Melter Feed Process Systems (HCP & HFP)*	B. Pratt/M. Kulp
B	Insertion of Section 4, System Description, into the SDD. Revision of the functional analysis table references D.2 and H.1 to incorporate changes with the system interfaces between the HFP system and the RLD system and identification of holds associated with pending changes in the PDSA revision. Enhanced section 3 requirement wording and added requirements based on ROINs not captured in the original revision.	Scott Peters
0	Removal of holds which were no longer required and addition of details to bound the active holds and how they related to the design. Removed code and standard requirements which overlapped with guidance in the Code of Record. Revised WAI requirements to better align with the IHLW Waste Form Compliance Plan. Updated section 4 with information from change notices posted against the superseded 24590-HLW-3YD-HFP-00001.	Scott Peters

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1 Introduction

1.1 System Identification

This system design description (SDD) defines the technical, functional and performance requirements of the high-level waste (HLW) concentrate receipt process system (HCP) and HLW melter feed process system (HFP). This document details the waste treatment requirements, environmental compliance requirements, and authorization basis requirements of the HCP and HFP systems as they are currently known and understood. This SDD describes the process and functional design requirements of the HCP and HFP systems, including the following:

- Services and utility requirements, operating materials and supplies, and other external interfaces
- Operations limits and design bases
- Other criteria and requirements pertinent to the design of the HCP and HFP systems

The HCP and HFP systems receive waste from the Pretreatment (PT) Facility, mix the waste with glass formers, ensure the waste meets established characteristics via sampling, and transfers the waste with glass formers to the melter system. The boundaries, system interfaces, and functional description of the HCP and HFP systems are provided in Sections 2 and 3.4.3.

1.2 Limitations and Scope

The scope of this document is to provide an authoritative source for the collected set of requirements applicable to the HCP and HFP systems, inclusive of interface requirements with other systems. The SDD scope is limited to HCP and HFP system features that support production and/or protect equipment, personnel, and the environment. The SDD is prepared in accordance with 24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions*. The intended use of these collected requirements is to establish the following:

- Inform the HCP and HFP system design effort
- Provide a validated basis upon which to confirm implementation of design requirements
- Provide the expected means of verification for requirements, including post-construction verification (i.e., startup and commissioning test objectives and acceptance criteria)

All requirements in this document are intended to be verified and implemented in design and/or physical configuration using a graded approach commensurate with importance and risk.

Where numeric values are provided within requirements in Section 3, these values are provided without additional margin. For example if a value is established in 24590-WTP-DB-ENG-01-001, Basis of Design (BOD), no attempt is made to remove any margin that may or may not have gone into the establishment of that value, neither has any margin been added. Where values are stated as minimums or maximums, there is no expectation that additional margin be applied in the verifications that the design requirements have been met. Testing required to be performed in accordance with external codes and standards must follow the rules established in those documents.

This document is intended to be used in support of design development, design verification, turnover, startup testing, and commissioning activities. This document will be maintained current relative to changes in source

requirements documents. Updates shall be made concurrent with these changes to source requirements, or implementation shall be tracked for completion in accordance with 24590-WTP-GPG-ENG-0170, *Impact Evaluation*.

Engineers are expected to be able to use the requirements in Section 3 of this document as input for design development without recourse to the upper-tier source documents or searches of the Technical Requirements Search Application (TRSA). Design engineers are still required to ensure the requirements contained with the discipline/functional standards incorporated by reference in Section 3 are followed. These documents contain additional criteria based on applications of external codes/standards, corporate best practices, and Engineering management expectations for a consistent approach to design.

Certain requirement statements in this document are preceded by a "[**HOLD**]" notation. This notation is used when there are unresolved technical issues, known inconsistencies among source requirements, or other management suspensions of work requiring resolution. Requirements with the "[**HOLD**]" notation may be used to proceed with preliminary or committed design (with inclusion of appropriate holds) but shall not be used in support of fabrication or construction until the "[**HOLD**]" is removed.

The contents of Sections 4, System Description, are being developed in a phased approach in support of future operations and maintenance. At this revision, only the contents of Sections 4.1.1 through 4.1.4 and Section 4.1.6 have been updated and verified. Sections 4.1.5, 4.2, 4.3 and 4.4 are currently reserved and will be updated in a later phase after the work to support completion of these sections has been completed.

1.3 Ownership and Maintenance

The Design Authority (DA) organization is responsible for the preparation and maintenance of this document through turnover of the included systems to Operations. Thereafter, maintenance of this document is the responsibility of the Plant Engineering organization; however, the Engineering DA organization retains responsibility for the establishment and definition of design requirements.

1.4 Definitions/Glossary

Confinement – For consistency, regardless of usage elsewhere, confinement is used in this document to denote the controls used to prevent or minimize the release or migration of airborne contaminants, including aerosols, hazardous vapors, or gases.

Containment – For consistency, regardless of usage elsewhere, containment is used in this document to denote the controls used to prevent or minimize the release or migration of liquid or liquid-entrained contaminants.

Feed Forward- An operational strategy in which the HMP melters process all HFP vessel contents. Transfers between melter trains may be necessary to dilute out-of-specification waste but transfers to RLD are not permitted.

Homogeneity- A HFP vessel waste composition having a weight percent solids bias under 4%.

Primary confinement / containment – The structures, systems, or components (SSCs) and their associated boundaries that confine or contain airborne and liquid contaminants under normal conditions.

Secondary confinement / containment – The structures or other design features that capture and prevent further spread or migration of airborne or liquid contaminants after they have escaped primary confinement or containment.

1.5 Acronyms and System Designators

Acronyms

A, I, R, T	analysis, inspection, demonstration, test
ADS	air displacement slurry
AHJ	authority having jurisdiction
ALARA	as low as reasonably achievable
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BOD	*Basis of Design*
BPVC	Boiler and Pressure Vessel Code
C&I	Controls and Instrumentation
CCN	correspondence control number
CDI	configuration data index
COM	commissioning
CON	construction
CTN	component tag number
D&D	decontamination and decommissioning
DA	Design Authority
DBE	design basis event
DOE	US Department of Energy
DVR	design verification report
ENG	Engineering
EQP	equipment qualification package
FCR	facility control room
GTC	general test criteria
HEPA	high-efficiency particulate air
HGR	hydrogen generation rate
HLW	High-Level Waste (Facility)
IHLW	immobilized high-level waste
LFL	lower flammability limit
MCR	main control room
MFPV	melter feed preparation vessels
MFV	melter feed vessels
MR	material requisition
MTG	metric tons of glass
NFPA	National Fire Protection Association
NSE	Nuclear Safety Engineering
ORD	*Operations Requirements Document*

P&ID	piping and instrumentation diagram
PAM	post-accident monitoring
PDSA	preliminary documented safety analysis
PT	Pretreatment (Facility)
R&T	Research and Technology
ROIN	requirement object identification number
SC	safety class
SDD	system design description
SDS	*Safety Design Strategy for High-Level Waste Facility*
SFC	single failure criteria
SRD	*Safety Requirements Document Volume II*
SS	safety significant
SSC	structures, systems, or components
SSRS	safety system requirement specifications
SQR	supplier quality representative
SU	startup
SUB	subcontractor
SUP	supplier
TAC	test acceptance criteria
UPE	Uninterruptible Power Electrical System
UPS	Uninterruptible Power Supply System
WAI	waste acceptance impacting
WG	water gauge
WTP	Hanford Tank Waste Treatment and Immobilization Plant
ZOI	zone of influence

System Designators

ASX	autosampling system
C5V	C5 ventilation system
DIW	demineralized water system
GFR	glass former reagent system
HCP	HLW concentrate receipt process system
HFP	HLW melter feed process system
HLP	HLW lag storage and feed blending process system
HMP	HLW melter process system
HOP	HLW melter offgas processing system
HPS	high pressure steam system
HSH	HLW melter cave support handling system
ISA	instrument service air system
LVE	low voltage electrical (480/208/120 V) system
NAR	nitric acid reagent system
PCJ	process control system

PCW	plant cooling water system
PPJ	programmable protection system
PVV	process vessel vent exhaust system
PWD	plant wash and disposal system
RLD	radioactive liquid waste disposal system

2 General Overview

The HCP provides HLW concentrate from the PT Facility HLW lag storage and feed blending process system (HLP) to the HFP. The boundary of the HCP begins outside the HLW Facility and ends before the HLW melter cave wallbox, where it transitions into the HFP. The HCP does not include any equipment, only transfer lines. The HFP supplies the HLW concentrate to the melter feed preparation vessels (MFPVs). The HLW concentrate is sampled in the MFPVs and the results are used to determine the quantity of each glass former that is added to the waste. Glass formers from the glass former reagent system (GFR) are added to HLW concentrate and mixed in the MFPVs to form the melter feed. The HFP boundary with the GFR begins at the isolation valve downstream of the HLW glass former mixer on the discharge line to MFPV. The waste with glass formers is sampled and adjusted as needed to meet the waste form specifications. The melter feed is transferred from the MFPVs to the melter feed vessels (MFVs) for staging. The MFVs may also be sampled, but this is not part of the normal process control. The MFVs are capable of supplying the melter feed to the HLW melter process system (HMP) with continuous feed for glass production. The HFP boundary ends after the MFV on the HLW HMP melter feed jumper before the HLW melter. The HFP contains the MFPVs and MFVs (HFP vessels), including the associated piping, inline components, and equipment such as pumps and agitators. All other boundaries between the HFP and other systems are defined based on their type of control.

Figure 2–1 provides a contextual depiction of the HCP and HFP systems in terms of their primary interrelationships with other systems and utilities. This diagram does not differentiate among some utilities that have both normal and safety service provisions. This diagram is used in support of functional and performance definition at the system level. Figure 2–2 provides a simplified process flow diagram of the overall HCP and HFP systems. Blue arrows are used in these figures to highlight the primary flow path of the HCP and HFP systems, orange arrows show the abnormal transfer lines between vessels in separate melter trains; and black arrows illustrate the supporting systems, utilities, and secondary flow paths. Refer to Section 1.5 for the list of relevant system designators.

Figure 2–1 HCP and HFP Context Diagram

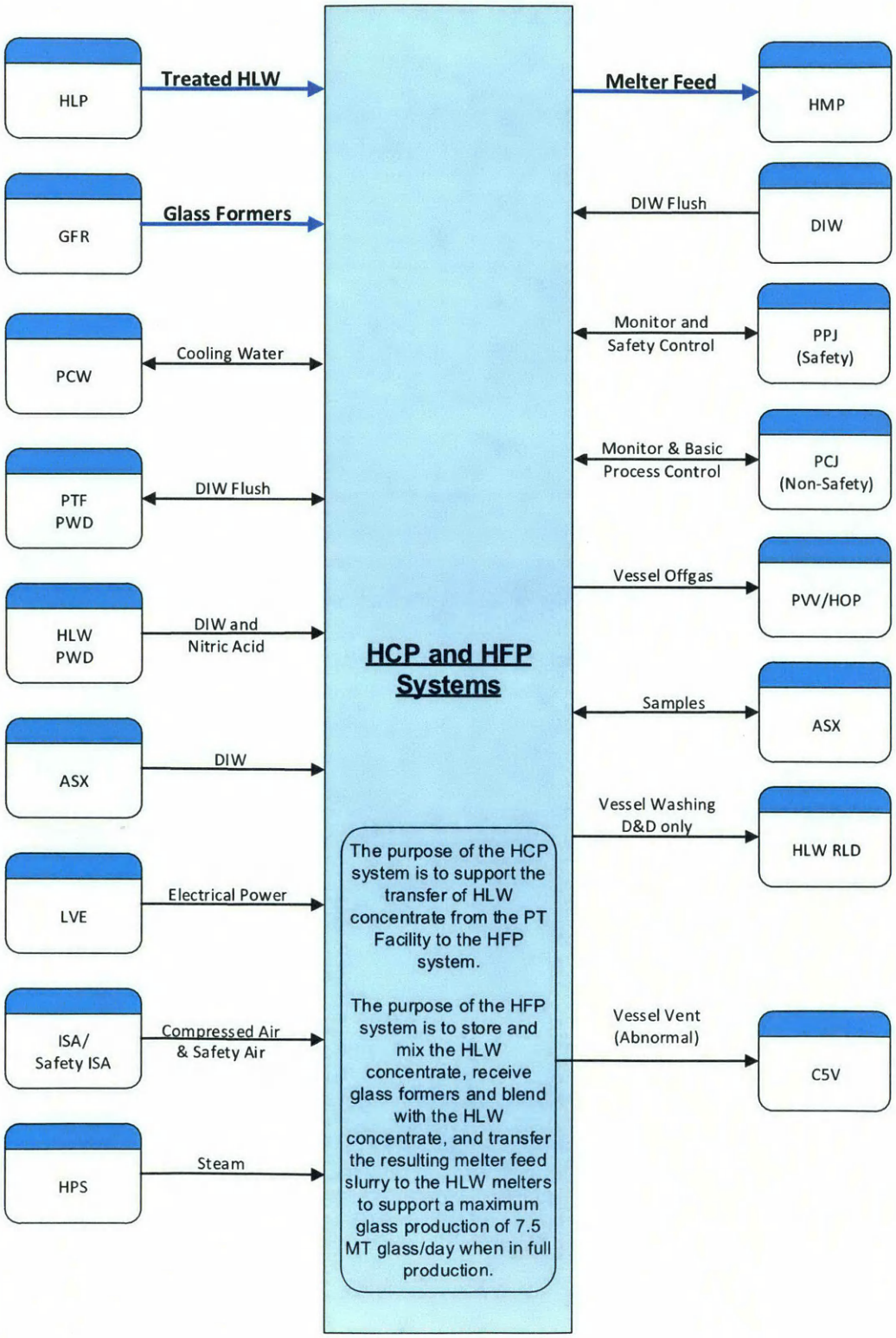
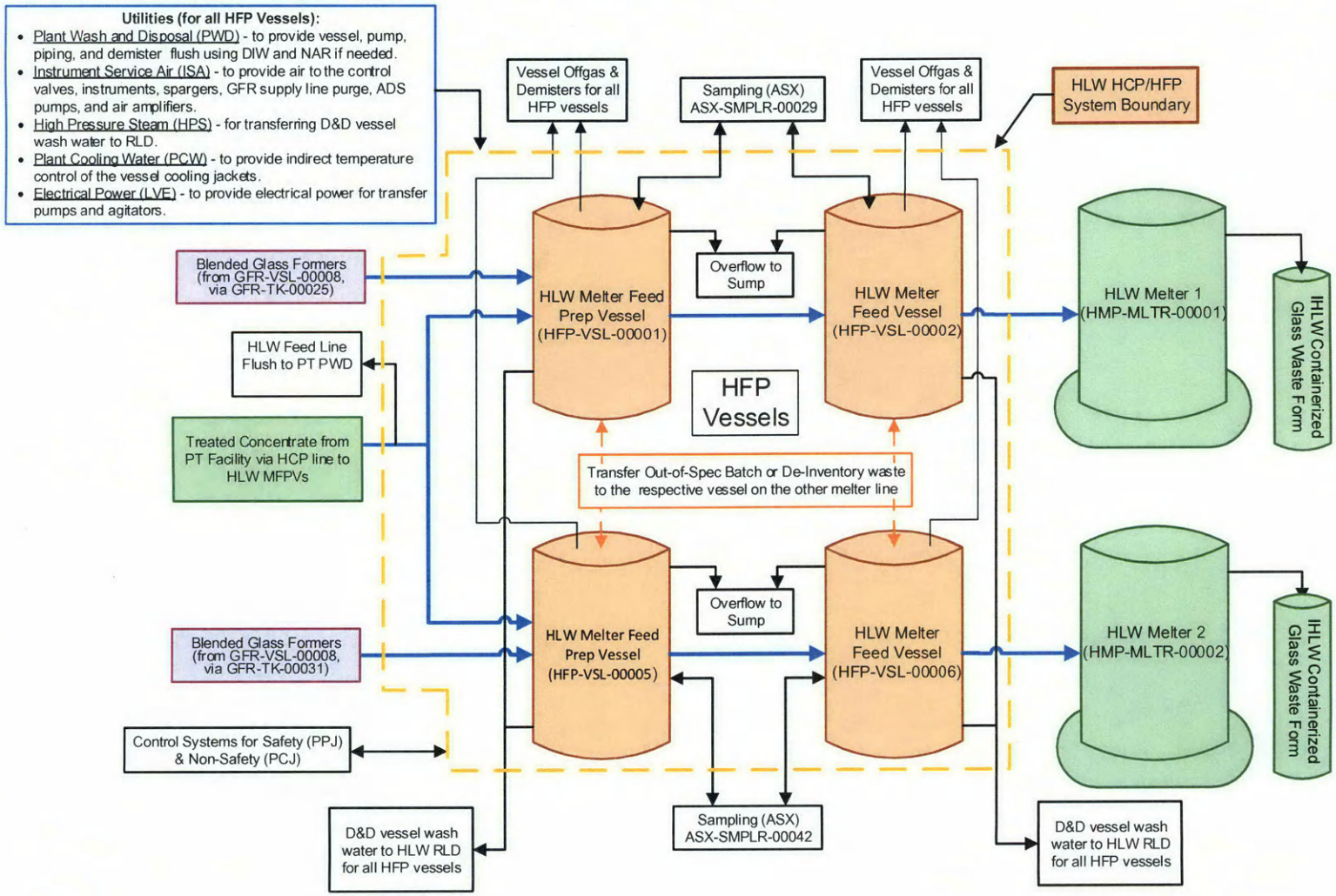


Figure 2–2 HCP and HFP Simplified Process Flow Diagram

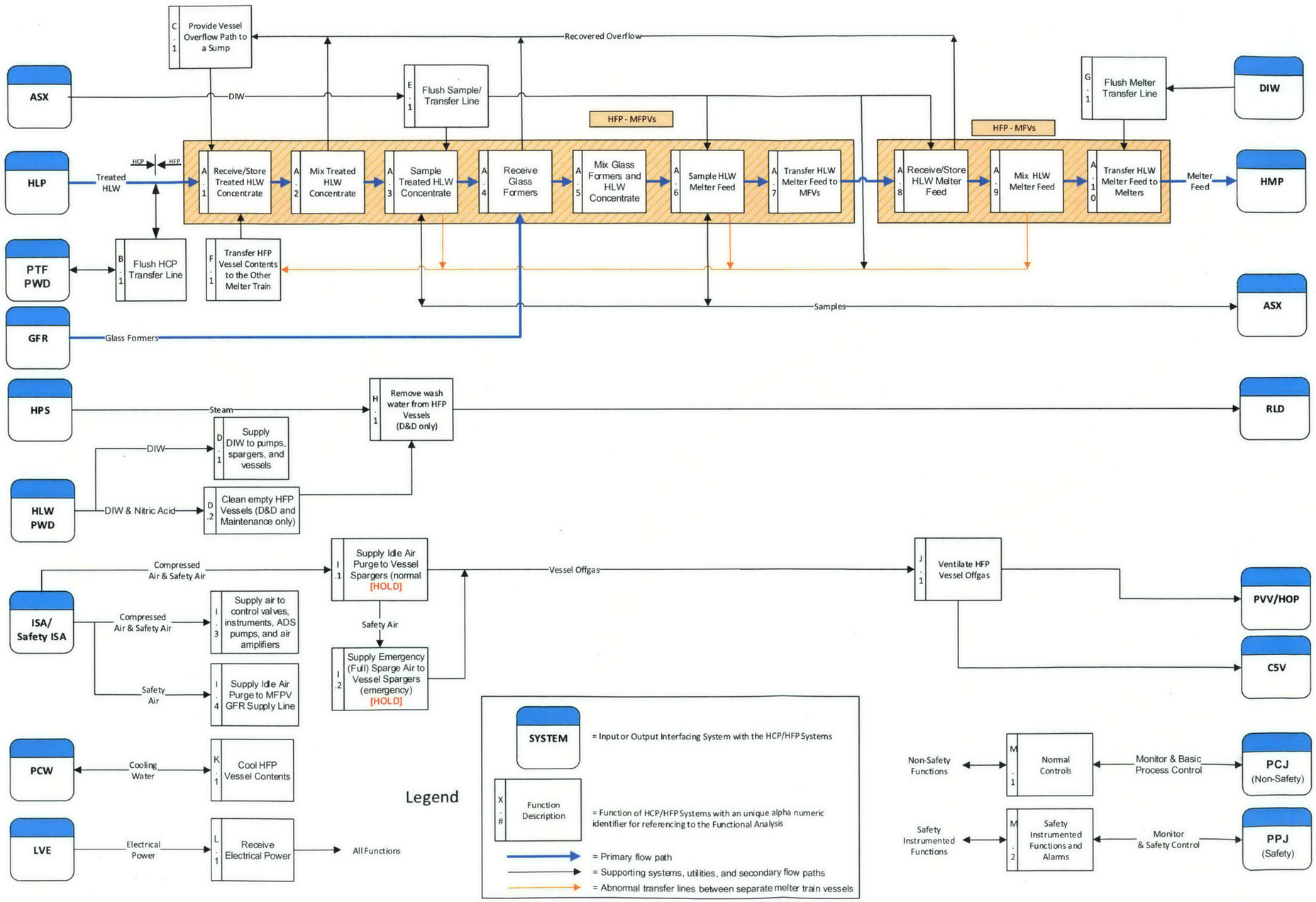


2.1 System Functions/Safety Functions

This section defines the HCP and HFP functions and attributes that need to be addressed by the system design. Figure 2–3 provides the functional block diagram for the HCP and HFP systems, indicating the internal and external systems and utilities that provide the primary support or interface for that function. Section 3 provides the design and performance design requirements to meet both functional and other requirements.

System interfaces are provided for reference only. Refer to Section 1.5 for the list of relevant system designators.

Figure 2–3 HCP and HFP Functional Block Diagram



The functions included in Figure 2-3 are the primary and secondary level functions of the HCP and HFP systems. These functions are further described in Table 2–1. Where appropriate to support definition of functional and design requirements, functions have been further decomposed and additional levels of supporting functions are also described. The requirement section number provides the location of the applicable functional analysis incorporated into system requirements.

Appendix B provides a further decomposition of system functions, including initiating, terminating, and integrating events and functions.

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
A.	**Receive Waste, Glass Formers, and Prepare HLW Melter Feed for Vitrification**	N/A
A.1	[**HOLD**] Receive/store treated HLW concentrate - The MFPV receives HLW concentrate from the PT Facility HLW lag storage and feed blending process system (HLP) via the HCP piping. The MFPV interfaces with the autosampling system (ASX) to sample and characterize the HLW concentrate.	3.5.1.1.1 3.5.3.1 3.6.2.2
A.1.1	[**HOLD**] Receive HLW sump flows- Sumps which could contain melter feed are routed to the MFPVs (via steam ejectors through the melter train cross connection).	3.4.4.6
A.2	Mix treated HLW concentrate - The HLW concentrate is mixed in the MFPV before transferring to the ASX, which collects a representative sample for analysis to determine the glass former recipe.	3.5.1.1.1 3.5.2.2 3.7.1.1.1 3.7.1.1.2
A.3	Sample treated HLW concentrate - The HLW concentrate is transferred from the MFPV by the HFP sample/transfer pumps to the sampling recirculation loop where the ASX extracts a sample. The remaining concentrate returns back to the MFPV using the HFP circulation loop. The ASX uses an auto sampler to extract a representative sample for analysis in the Analytical Laboratory. Sample data is collected for each MFPV batch to ensure an adequate quantity of glass formers is added for final waste characterization to meet glass property and waste loading requirements.	3.4.1.1.3 3.5.3.9
A.3.1	[**HOLD**] Flush sample line - Demineralized water is used to flush the sample recirculation line into the MFPV via the ASX system.	3.5.3.10 3.6.3.1
A.4	Receive glass formers - MFPV receives glass formers from the GFR system. The proper proportions of various glass formers are prepared, mixed, moistened, added to the HLW concentrate, and mixed to prepare HLW feed material. (See A.6).	3.5.3.2
A.5	Mix glass formers with HLW concentrate - A mechanical agitator mixes glass formers and HLW concentrate in the MFPV to ensure data quality objectives are met in support of waste form qualification.	3.7.1.1.1 3.7.1.1.2

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
A.6	Sample HLW melter feed - Representative samples of the HLW melter feed are transferred from the MFPV by the HFP sample/transfer pumps to the sampling recirculation loop where the ASX extracts a sample. The ASX sample is analyzed to confirm the melter feed meets glass property and waste loading requirements for each particular batch. If the melter feed is not acceptable, additional glass formers can be added and mixed to shim the batch. The shimmed batch is then resampled to ensure the final glass product will meet the acceptance criteria.	3.4.1.1.3 3.5.3.9
A.6.1	**[HOLD]** Flush sample line - Demineralized water is used to flush the sample recirculation line into the MFPV.	3.5.3.10 3.6.3.1
A.7	Transfer HLW melter feed to MFVs - The HLW melter feed is transferred from the MFPV to the MFV.	3.4.1.1.1 3.5.3.3
A.8	Receive/Store HLW melter feed – The MFV receives and stores HLW melter feed from the MFPV until it is transferred to the melter.	3.5.3.3
A.9	Mix HLW melter Feed - The HLW melter feed is continuously mixed while being staged in the MFV before transferring to the melter for vitrification.	3.7.1.1.1 3.7.1.1.2
A.10	**[HOLD]** Transfer HLW melter feed to melters - Except for periodic line flushes, HLW feed is continuously transferred from the MFV to the melter for vitrification as a continuous low volumetric rate stream.	3.4.1.1.2 3.5.3.4 3.9.1.2 3.9.3.2.1
B.	**Prevent plugging of the PT Facility to HLW Facility transfer line**	N/A
B.1	Flush HCP transfer line - The HCP transfer line will be flushed to prevent plugging and the accumulation of detonable quantities of hydrogen. The flush water will be directed back to the PT Facility plant wash and disposal system (PWD).	3.4.4.3 3.6.3.1 3.6.4.1
C.	**Prevent Liquid Uptake into the Process Vessel Vent Exhaust System (PVV)**	N/A
C.1	Provide vessel overflow path to a sump - MFPVs and MFVs (HFP vessels) are designed with an overflow path to preclude liquid uptake into the process vessel vent exhaust system (PVV) and maintain a minimum headspace volume. Overflowed liquid will be directed from the HFP vessel to the respective melter cave sump.	3.5.2.1.1 3.5.2.1.2 3.5.2.1.3
D.	**Supply HFP Vessels with Demineralized Water and Nitric Acid from HLW PWD and NAR**	N/A
D.1	Supply Demineralized Water - Demineralized water is provided to the pumps, spargers, and HFP vessels.	3.5.3.5
D.1.1	Demineralized water is used for priming the sample/transfer pumps to clear the pump and to initiate the pump, without waste, until the pump reaches operating capacity.	3.9.3.1.1
D.1.2	**[HOLD]** Demineralized water is used for flushing the spargers to prevent them from plugging.	3.8.4.1
D.1.3	Demineralized water is used for diluting the waste in the HFP vessels via the spargers or internal spray mechanisms.	3.5.3.11

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
D.2	Clean empty HFP vessels - HFP vessels are washed using demineralized water and nitric acid from the nitric acid reagent system (NAR), if needed, via the PWD. The washwater is transferred from the HFP vessels to the radioactive liquid waste disposal system (RLD) using the steam ejectors to support vessel decontamination and decommissioning (D&D) (see H.1). Vessel Washings during normal operations will be processed forward to the melters.	3.5.3.5 3.5.4.1
E.	**Flush Sample/Transfer Lines with Demineralized Water from ASX**	N/A
E.1	**[HOLD]** Flush sample/transfer line - The HFP vessel sample loops and transfer line from the MFPV to MFV are flushed using demineralized water to prevent lines from plugging. The lines are flushed into the HFP vessels.	3.6.3.1 3.6.4.1 3.6.3.2 3.10.4.4
F.	**HFP Vessel Cross-Tie Between Melter Trains**	N/A
F.1	Transfer HFP vessel contents - The HFP vessel contents are removed and transferred to the other melter train either upon receipt of an out-of-specification batch sample analysis or to de-inventory the waste.	3.4.4.2
G.	**Prevent plugging of the MFV to Melter Transfer Line**	N/A
G.1	Flush melter transfer line - The transfer piping from the MFV to the melter will be flushed to prevent plugging.	3.6.3.1 3.6.4.1
H.	**Remove Vessel Wash Contents**	N/A
H.1	Remove washwater from HFP vessels – Vessel washwater will be processed forward to the melters during normal operations. During vessel D&D activities, the high-pressure steam system (HPS) provides steam to the steam ejectors to remove the MFPVs and MFVs (HFP vessels) and transfers the liquid to the RLD.	3.4.4.4 3.5.3.8 3.5.4.1 3.5.3.11
I.	**Supply HFP Vessels with Air for Purge/Sparge, Control Valves, Instruments, and Air Displacement Slurry Pumps from ISA and Safety ISA**	N/A
I.1	**[HOLD]** Supply idle air purge to vessel spargers - The sparger lines provide compressed air from the instrument service air system (ISA) to provide a trickle flow (idle air purging) during normal mixing operations. The trickle flow is provided to lower the risk of sparging line plugging and to prevent the buildup of hydrogen gas in the vessel headspace.	3.8.2.1 3.8.3.1
I.2	**[HOLD]** Supply emergency (full) sparge air to vessel spargers - The sparger lines provide compressed air from ISA to provide emergency air sparging to mix the waste after a seismic design basis event (DBE). The emergency sparging provides agitation of the waste sufficient to preclude retention of hydrogen in the waste when normal agitation is unavailable either post-seismic DBE or maintenance.	3.8.2.1 3.8.3.2
I.3	Supply air to control valves, instruments, air displacement slurry (ADS) pumps and air amplifiers. Air is used to supply the motive force to open/operate control valves, instruments, ADS pumps, and air amplifiers.	3.9.3.2.1 3.11.3.1.1 3.11.3.2.1

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
I.4	Supply idle air to purge to MFPV GFR supply line. Air is used to prevent backflow of contamination from the MFPVs to the GFR during normal operation.	3.5.3.12
J.	**Ventilate Vessel**	N/A
J.1	Ventilate HFP vessel offgas - Negative headspace pressure is maintained in the HFP vessels by the PVV and HLW melter offgas treatment process system (HOP). The HFP vessels are vented by air amplifiers or an overflow feature into the melter cave where the headspace gas is removed by the C5 ventilation system when HOP/PVV is unavailable.	3.5.3.7.1
J.1.1	Demisters are used to prevent excessive moisture and aerosols from being carried out of the HFP vessels into the HOP high-efficiency particulate air (HEPA) filters.	3.11.1.1
K.	**Cool Vessel**	N/A
K.1	Cool HFP vessel contents - HFP vessels are cooled using water jackets and chilled water from the plant cooling water system (PCW) to remove heat generated by mixing and radioactive decay.	3.5.3.6
L.	**Electrical Power**	N/A
L.1	Receive Electrical Power - The low voltage electrical (480/208/120 V) system (LVE) provides electrical power to the HFP equipment and instruments.	N/A
M.	**Support Monitoring, Control, and Communication Functions**	N/A
M.1	Process Control System (PCJ) - Normal Controls	3.10.3.2
M.1.1	The HCP / HFP process shall be monitored and controlled by the PCJ system and shall include the following main functions: a) Control incoming PT Facility waste transfers and melter feed (including line flushes) b) Monitor vessel level, temperature and pressures c) Control operation of valves, pumps, ejectors, agitators, sampling and cooling systems d) Monitor device status (valve, pumps etc.) e) Monitor sample line flow f) **[HOLD]**Monitor sparge flows g) Monitor cooling water flow h) Automatic flushing control	a) 3.5.1.1.1 3.10.4.1 b) 3.5.1.1.1 3.5.1.1.2 3.5.1.1.3 3.10.1.1.1 3.10.1.1.2 3.10.1.1.3 3.10.1.1.4 3.10.4.1 c) 3.5.1.1.2 3.10.2.2.4 3.10.4.1 d) 3.10.4.1 e) 3.10.1.4.1 3.10.4.1 f) 3.8.3.1 3.10.1.3.1 3.10.4.1 g) 3.5.3.6 3.10.4.1 h) 3.10.4.4

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
M.1.2	The PCJ system shall allow the remote monitoring and control of the HCP / HFP systems from the HLW Facility Control Room (FCR) and Main Control Room (MCR) in the PT Facility.	3.10.4.1
M.2	Programmable protection system PPJ - Safety Instrumented Functions and Alarms	3.10.2.3 3.10.2.5 3.10.3.1
M.2.1	Isolate valves for transferring and sampling - The PPJ provides automatic safety termination of transfers from the PT Facility to the MFPVs, from the MFVs to the melters, from HFP vessels to ASX samplers. Position indication needs to be provided by the monitoring capability on both PPJ and PCJ systems.	3.10.2.2.3 3.10.1.4.2 3.10.2.2.4 3.10.2.2.1 3.10.4.1 3.10.4.2 3.10.4.4
M.2.2	[**HOLD**] Isolate sample/transfer pumps - The PPJ stops the sample/transfer pumps for safety interlocks.	3.10.2.2.3 3.10.2.2.4 3.10.4.2
M.2.3	[**HOLD**] Isolate air displacement slurry (ADS) pumps - The PPJ stops the ADS pumps for safety interlocks.	3.10.1.4.2 3.10.4.2
M.2.4	[**HOLD**] Switch from idle air purge mode to emergency sparge mode - The PPJ controls the airflow through the sparge tubes and switches from idle air purge mode to emergency sparge mode after the mechanical agitator speed or power drops below setpoint values.	3.10.1.2.3 3.10.1.3.2 3.10.4.2
M.2.5	[**HOLD**] Measure air sparger flow rate - For emergency sparging, the PPJ provides monitoring of the volume rate of air flowing through the sparger air supply lines.	3.8.3.2 3.10.1.2.3 3.10.1.3.2 3.10.1.3.3 3.10.2.1.3 3.10.4.2
M.2.6	Measure mechanical agitator speed - The PPJ monitors the rotational speed of the mechanical agitators to ensure adequate mixing of the waste.	3.10.1.2.1 3.10.1.2.3 3.10.2.1.2 3.10.4.2
M.2.7	Measure mechanical agitator power - The PPJ monitors the motor power of the mechanical agitators to ensure agitators are operating above the minimum amperage setpoint.	3.10.1.2.2 3.10.2.1.2 3.10.4.2
M.2.8	[**HOLD**] Operate safety air valves for sparging - The PPJ controls the automatic operation of the safety air valves to transition from normal non-safety ISA to safety ISA when flow rates drop below the setpoint.	3.10.1.3.3 3.10.2.1.3 3.10.4.2
M.2.9	Measure vessel contents level - The PPJ monitors the level of the vessel contents.	3.10.1.1.3 3.10.1.1.3 3.10.2.2.1 3.10.4.2

Table 2–1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
M.2.10	**[HOLD]** Operate valves for receiving glass formers - The PPJ provides automatic safety closure of the glass former feed isolation valve.	3.10.2.1.1 3.10.2.2.2 3.10.4.2
M.2.11	Operate air amplifiers - The PPJ system to receive seismic signal safety class (SC) interlock signal, which will automatically activate the air amplifiers on each HFP vessel in response to a seismic event.	3.10.2.1.4 3.10.4.2 3.11.2.1.1

2.2 System Classification

The HFP and HCP systems contain components with the following classifications/designations:

- ☒ Safety Class
- ☒ Safety Significant
- ☒ Dangerous Waste Permit affecting
- ☐ Air Permit affecting
- ☒ Waste Acceptance Impacting
- ☒ General

2.3 Basic Operational Overview

A functional description of the system is provided in Sections 2 and 2.1, which provide the context diagram for the system, interfaces with other systems, a simplified system diagram, a functional block diagram, and descriptions of the system functions. A basic operational system overview is described in this section. Detailed operational information is provided in Section 4.

The HCP and HFP systems are located in the HLW Facility of the Hanford Tank Waste Treatment and Immobilization Plant (WTP). The HCP receives HLW concentrate from the PT Facility HLP and delivers it to the HFP. The HCP does not include any equipment, only transfer lines. The HFP MFPVs receive the HLW concentrate from the HCP and interfaces with the ASX to characterize the waste. The HLW concentrate is mixed, sampled, and characterized. HFP liquid waste is waste regulated under 42 USC 6901, *Resource Conservation and Recovery Act of 1976*. The waste must meet specific treatment and performance standards for storage and repository disposal of the final waste form in accordance with the specific requirements of US Department of Energy (DOE) Contract DE-AC27-01RV14136, *DOE/BNI WTP Contract Mod No. 304, Section C - Statement of Work* (WTP Contract). The sample results determine the quantity of each glass former added to the waste to produce glass that meets glass property and waste loading requirements for each particular batch. The proper proportions of various glass formers are prepared, mixed, moistened, added to the HLW concentrate, and mixed to prepare the HLW melter feed. A confirmatory sample is used to ensure the resultant glass product will be acceptable to the DOE. The resulting compliant melter feed is transferred from the MFPVs to the MFVs. The melter feed is transferred from the MFV into one of the two-joule heated HLW melters, which are part of the HMP. The melter glass output mixture will be poured into stainless-steel canisters. The vitrified waste in the canisters is referred to as immobilized high level waste (IHLW).

3 Design Requirements

3.1 Requirements

Requirements are documented in Sections 3.4 through 3.12. Each requirement statement is accompanied by a basis discussion (as needed) and the expected means of verification. Requirements must be met in design. If a requirement stated in this document cannot be met in design, a revision to the requirement needs to be pursued, if possible, or the design must be changed to meet the requirement.

Requirements preceded by "[**HOLD**]" may only be used in support of preliminary or committed design, which shall also be issued with appropriate holds per procedure 24590-WTP-3DP-G04B-00046, *Engineering Drawings*. These requirements may not be used in support of fabrication or construction.

The following abbreviations are used to designate the selected method for verification (see 24590-WTP-3DP-G04B-00092, *System Verification*, for additional guidance concerning methods of verification):

(A) Analysis
(R) Review
(I) Inspection
(T) Test

The following abbreviations are used to designate the organization responsible for performing the verification:

(ENG) Engineering
(CON) Construction
(SU) Startup
(COM) Commissioning
(SUP) Supplier
(SUB) Subcontractor
(SQR) Supplier Quality Representative
(REC) Receiving

3.2 Bases

Basis discussions are provided as needed to explain the decomposition or interpretation from the originating source requirement(s). Where a [**HOLD**] has been applied to a requirement, this section will include the basis for the [HOLD]. Where included, basis discussions provide supplementary information to help the reader understand the origin or intent of a requirement. Basis statements do not include requirements and are not to be considered as requirements.

3.3 References

The requirements include a source document reference. Each unique source document reference is bracketed separately. Requirements may include a reference to the Section 2.1, Functional Description, listed in parentheses

following the source document and ID number references. A complete listing of all source references is provided in Section 5.1.

3.4 General Requirements

3.4.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.4.1.1 HFP Vessel Transfer Rates

3.4.1.1.1 MFPV to MFV Transfer Rate

Requirement: The HFP system shall provide a sufficient transfer flow rate to support the 100% capacity melter throughput for glass production of 3.75 metric tons of glass(MTG)/day/melter (total of 7.5 MTG per day) for transfers from the MFPV to the MFV. [Section C.7(b)(3), No. DE-AC27-01RV14136] [Section 6.3.3, 11.7.4, BOD](A.7).

Basis Discussion: The design throughput (processing) capabilities for the HCP and HFP systems are defined in Section 6.3.3 of the BOD. Software models are used to validate the design throughput capacity is met by the designed systems, inclusive of treatment processes, individual system and component capabilities, and equipment reliability and maintainability inputs. The HFP is designed to accommodate the receipt and treatment of specific waste volumes, using batch processing capabilities, to meet the design throughput requirements. The throughput rates are a function of the feed characteristics in a given batch volume. Batch volume and nominal transfer rate are used as inputs in the overall throughput analysis to ensure HCP and HFP systems operations are designed to support the 100 % capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day), as stipulated in the WTP Contract. As stated in the BOD, the 44 gpm nominal transfer rate is considered a key design feature assumed in modeling and ORP concurrence is required before the capability can be reduced in design.

Section 6.3.3 of the BOD states the design throughput transfer rate is 44 gpm which should be the nominal target design for the pump. However, Section 7.7.4 of 24590-HLW-MVC-HFP-00001, Process Information for HFP Vessels (HFP-VSL-00001, HFP-VSL-00002, and HFP-VSL-00005, and HFP-VSL-00006), determined the minimum transfer rate to be 35 gpm. 44 gpm is considered to be the nominal transfer rate, recognizing that actual transfer rates may be faster or slower depending on the actual waste characteristics. In addition, 24590-101-TSA-W000-0004 -172-00001, Final Technical Basis for HLW Vitrification Stream Physical and Rheological Property Bounding Conditions, and PIBOD, 24590-WTP-DB-PET-09-001 table B-4 specify the transfer rate must be accomplished at a bounding rheology of 30 Pa and 40 cP(refer to 24590-WTP-GPG-M-0058, Section 4.5.1, *Minimum Flow Velocity for Slurry Lines*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the HCP and HFP piping systems to determine the MFPV to MFV transfer rates required to satisfy facility throughput.	
R	ENG	Review the design to verify conformance with the analysis.	
T	SUP	Obtain test data from the supplier validating the minimum flow rate.	**Component Tag Numbers (CTN):** HFP-PMP-00018A, -00018B, -00005A, -00005, -00007, and -00017. **Test Conditions:** Simulant with a viscosity of ≥40 cP and yield stress of ≥30 Pascal (Pa) or an approved alternative (i.e., in an approved supplier test plan) **Acceptance Criteria:** Meets 44 gpm or higher at test conditions
T	SU/COM	Perform integrated system test to verify the MFPV to the MFV transfer rate complies with the analysis.	

3.4.1.1.2 MFV to Melter Transfer Rate

Requirement: [**HOLD**] The HFP system shall provide a transfer flow rate sufficient to support the 100% capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day) for transfers from the MFV to the melter. [Section C.7(b)(3), No. DE-AC27-01RV14136] [Sections 6.3.3, 11.7.4, BOD](A.10).

Basis Discussion: The design throughput (processing) capabilities for the HCP and HFP systems are defined in Section 6.3.3 of the BOD. Software models are used to validate the design throughput capacity is met by the designed systems, inclusive of treatment processes, individual system and component capabilities, and equipment reliability and maintainability inputs. The HFP is designed to accommodate the receipt and treatment of specific waste volumes, using batch processing capabilities, to meet the design throughput requirements. The throughput rates are a function of the feed characteristics in a given batch volume. Batch volume and nominal transfer rate are used as inputs in the overall throughput analysis to ensure HCP and HFP systems operations are designed to support the 100 % capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day), as stipulated in the WTP Contract. As stated in the BOD, the 2 gpm nominal transfer rate is considered a key design feature assumed in modeling and ORP concurrence is required before the capability can be reduced in design.

Section 6.3.3 of the BOD includes a transfer rate of 2 gpm, but calculation 24590-HLW-MVC-HFP-00001 determined the minimum transfer rate to be 2.53 gpm. The 2.53 gpm is considered to be the nominal transfer rate recognizing that actual transfer rates may be faster or slower depending on the actual waste characteristics. In addition, 24590-101-TSA-W000-0004-172-00001 specifies the transfer rate must be accomplished at a bounding rheology of 30 Pa and 40 cP. The rate (2.53 gpm) is based on the combined flow with both ADS pumps

operating. This requirement and the associated ADS pump design is on "[**HOLD**]" until the BOD is updated to reflect the bounding minimum required transfer rate.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the HCP and HFP piping systems to determine the MFV to melter transfer rate required to satisfy facility throughput.	
R	ENG	Review the design to verify conformance with the analysis.	
T	SUP	Obtain test data from the supplier validating the minimum flow rate.	**CTNs:** HFP-PMP-00001, -00002, -000014, and -00015. **Test Conditions:** Simulant with a viscosity of ≥40 cP and yield stress of ≥30 Pa or an approved alternative (i.e., in an approved supplier test plan) **Acceptance Criteria:** Meets 2 gpm or higher at test conditions
T	SU/COM	Perform integrated system test to verify the ADS pumps are capable of providing a minimum transfer rate, as determined by the analysis, from the MFV to the melter sufficient to support HLW throughput.	The BOD specifies a nominal 2 gpm based on the combined flow with both ADS pumps operating.

3.4.1.1.3 Minimum Sampling Transfer Rate

Requirement: The HFP system shall provide a transfer flow rate to the ASX sample extraction point that supports a 90 percent confidence level that the sample is within ± 10% of the true value in the HFP vessels. [Section 4.1.2.2, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] [Section 11.7.4, BOD](A.3, A.6).

Basis Discussion: The HFP sample/transfer pumps provide the motive force, adequate to maintain homogeneous mixture characteristics, for the vessel contents to pass through the HFP sampling recirculation loop where an ASX autosampler extracts a sample for analysis in the Analytical Laboratory. Due to the solids content of the sample slurry, the recirculation line velocity must meet or exceed the flow rate to prevent settling of solids in the sample loop piping that could cause an unrepresentative sample to be taken (24590-HLW-WSF-ENG-07-005, *WAI Screening of HFP Sample Loop Flow Meter*). In addition, 24590-101-TSA-W000-0004 -172-00001, Final Technical Basis for HLW Vitrification Stream Physical and Rheological Property Bounding Conditions, and PIBOD, 24590-WTP-DB-PET-09-001 table B-4 specify the transfer rate must be accomplished at a bounding rheology of 30 Pa and 40 cP while not exceeding 10 feet per second (fps). The MFVs are designed to interface with the ASX for sampling, but the pumps are not to be installed unless sampling is needed. The BOD infers the transfer rate must be achieved with the number of pumps kept to a minimum. A similar test, using the target flow rate of 44 gpm, was performed during the Vitreous State Laboratory's testing (refer to Section 4.4.10, Figures

4.108 and 4.109, 24590-101-TSA-W000-0009-195-00003, *Report – Pretreated Waste and Melter Feed Composition Variability Testing using HLW Simulants*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the HFP systems to determine the required sampling transfer rate to maintain homogeneity.	
R	ENG	Review the design to verify conformance with the analysis.	
T	SU/COM	Perform integrated system test to verify the sample/transfer pumps are capable of providing a minimum transfer rate to maintain homogeneity from the MFPV to the ASX.	Section 6.4 of WAI Screening of HLW Glass Chemistry Processing Activities specifies the "slurry flow rate must be within the range established during VSL testing." The value used in testing was 44 gpm.

3.4.1.2 Design Life

3.4.1.2.1 Design (Operating) Life

Requirement: All non-replaceable and non-maintainable HCP and HFP SSCs located within cells where routine access in not possible shall be designed to have an operating life with that of the facility, 40 years. All other HCP and HFP SSCs shall be designed to be replaceable and maintainable to meet the overall 40-year operating life of the facility.: [Section C.7(a)(1), WTP Contract][Sections 11.1.1, 11.7.4, 11.8.3, 15.3.1, BOD][Sections 5.6.2, 5.6.5, PDSA - HLW Facility][Safety Criterion 4.4-1, 4.4-3 Appendix H - Sections 3.8, 4.0, SRD,][Sections 14.1, 14.2, ORD].

Basis Discussion: Equipment and material selection is based on proven performance, value engineering principles, and fit-for-function principles. The selection of equipment and materials is further addressed in detail as the design progresses. Equipment design needs to consider the routine environmental exposures under normal operations for non-safety equipment; safety and post-accident monitoring (PAM) equipment also consider abnormal and emergency exposures-this minimizes the need for equipment maintenance, exposure, and radiological waste generation in radiological areas.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	The "qualified" design life verification for safety and PAM SSCs is to be verified through review of equipment design as documented in equipment qualification packages (EQP).	Design life for safety and PAM equipment to be documented in equipment qualification package.

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify design life of non-replaceable, non-maintainable SSCs is documented in procurement documents and supported by supplier certificates of conformance or verify SSCs have been designed to be replaceable and maintainable to meet the overall 40-year operating life of the facility.	May be documented in an evaluation/assessment

3.4.1.2.2 Materials of Construction and Erosion/Corrosion Design Parameters

Requirement: The HFP/HCP system shall be designed to include allowance for erosion/corrosion and use materials of construction , including wear resistant coatings in accordance with: [Safety Criterion 4.2-3, Appendix H Section 4.0, SRD][Appendix C.2.3.1 and Sections 6.1, 11.4.1, 11.8.3, 11.8.3.1, 14.10.1, 16.4.1.4, 16.4.2.8, BOD][Sections 9.1, 20.0, ORD].

Basis Discussion: The allowance for erosion/corrosion and applicable materials of construction are limited to those components that come into contact with the process fluids and that are required to maintain confinement/containment of those process fluids. Materials of construction that can withstand the erosive/corrosive low-activity waste effluents and chemicals are selected. The materials for the HFP system equipment and components should be selected based on the stream data presented in the process corrosion data sheet report. If vessel washing via internal spray mechanisms is needed to prevent or minimize corrosion, the operational limitations shall be identified in the vessel corrosion evaluation. Refer to Tables A-14, B-4, B-5, 24590-WTP-DB-PET-09-001, Process Inputs Basis of Design [PIBOD]); and 24590-WTP-M4C-V11T-00024, *WTP Process Flowsheet Mass & Energy Balance Analysis for Input to Material Selection Assessments,* for the fluid characteristics of the process streams.

The HFP/HCP system streams are accounted for in the erosion and corrosion analyses and are fabricated with materials of construction that can withstand the radioactive, thermal, and erosive/corrosive environment caused by the material. Design and verification is expected to be to the most recent issued revisions of the listed corrosion evaluations. If vessel washing via internal spray mechanisms is needed to prevent or minimize corrosion, the operational limitations are identified in the vessel corrosion evaluation.

Details of the allowed materials corrosion allowances can be found in:

- 24590-HLW-N1D-HFP-00002, *HFP-PMP-00007 and HFP-PMP-00017 HLW - Melter 1 and 2 Feed Vessel Sample - Recirc Pump*
- 24590-HLW-N1D-HFP-00003, *HFP-VSL-00001 and HFP-VSL-00005 HLW - HLW Melter 1 and 2 Feed Preparation Vessel*
- 24590-HLW-N1D-HFP-00004, *HFP-VSL-00002 and HFP-VSL-00006 HLW - Melter 1 and 2 Feed Vessel*

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Perform an analysis/inspection of materials used in the HFP/HCP system which are in contact with, and are required to maintain confinement or containment of, the process fluids to verify that they are acceptable for use in the operating environment and have adequate erosion and corrosion allowances.	
R	ENG	Review design components used in the HFP/HCP system which are in contact with, and are required to maintain confinement or containment of, the process fluids for concurrence with analysis.	

3.4.1.2.3 Room Environment Conditions for Safety SSCs

Requirement: The safety equipment in the HLW HFP/HCP system credited with a safety function(s) and post-accident monitoring instruments (24590-HLW-RPT-ENS-12-002, HLW Preliminary Post Accident Monitoring Report) shall be designed and qualified to perform their safety functions as intended in the environment conditions associated with the events for which they are intended to respond, inclusive of aging effects throughout their qualified life. [Safety Criterion 4.4-1, 4.3-4, SRD][Section 11.7.3, BOD].

Basis Discussion: Safety SSCs designated as Safety Class (SC) and Safety Significant (SS) are designed and qualified to function as intended in the room environment conditions associated with the events for which they are intended to respond. The effects of aging on normal and abnormal functioning are considered in design and qualification. Data Sheet 24590-HLW-U0D-W16T-00001, HLW room environment datasheet, identifies environment conditions for rooms that house safety SSCs.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing to verify the ability of the SSCs credited with a safety or PAM function to withstand specified environmental conditions for the rooms in which they are installed.	Document in EQP. See HLW Room Environment Data Sheet (24590-HLW-U0D-W16T-00001) for room environmental conditions.
R	ENG	Review of design to verify compliance with the HLW room environment data sheet conditions.	May be accomplished by EQP or separate evaluation/assessment and supplier certificates of conformance.

3.4.1.2.4 Room Environment Conditions for Non-Safety SSCs

Requirement: Non-safety equipment/components shall be designed to operate and withstand the service conditions per Table 12-1 in the BOD. [Table 12-1 BOD][Sections 11.16, 16.1, ORD].

Basis Discussion: Non-safety SSCs are designed to function as intended in the room environment conditions associated with their location.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design of non-safety, active SSCs to ensure compliance with BOD Table 12-1 conditions.	May be documented in an assessment/evaluation report.

3.4.1.2.5 Nonmaintainable Soft or Nonmetallic Parts

Requirement: The system equipment and components shall be designed with no nonmaintainable soft or nonmetallic parts in hard-to-reach areas that could be affected by the total integrated radiation dose including gamma and beta. [Section 16.4.1.1, BOD].

Basis Discussion: The HCP and HFP equipment and components are designed to withstand the internal beta radiation of the applicable process streams (i.e., HLP09, HFP06, or HFP03), and external gamma radiation (room) dose.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of Design to verify there are no hard-to-reach soft or nonmetallic parts.	May be accomplished by EQP or separate assessment.

3.4.1.2.6 Seismic Design

Requirement: The HCP and HFP system equipment, including PAM, shall be designed for seismic conditions in accordance with Table 3–1: [Sections 3.4.2.1.1.5, 3.4.2.1.1.6, 4.3.7.1, 4.3.7.2, 4.3.7.3, 4.3.7.3.4, 4.3.8, 4.3.15, 4.4.7, 4.4.27 Appendix 4B, PDSA - HLW Facility][Appendix 3A, PDSA - PT Facility][Sections 16.4.2.1, 16.4.2.8, BOD] [Safety Criterion 4.1-3, 4.3-4, SRD].

Table 3–1 HCP and HFP Seismic Design Categories

Description	Seismic Category	Reference
MFPVs (HFP-VSL-00001 /00005)	SC-I	Sections 3.4.2.1.1.5, 4.3.7.1, PDSA - HLW Facility and Section 16.4.2.1, BOD
MFVs (HFP-VSL-00002/00006)	SC-I	Sections 3.4.2.1.1.5, 4.3.7.1, PDSA - HLW Facility and Section 16.4.2.1, BOD
Air amplifier system (HFP-EJCT-00006/00007/00008/00009)	SC-I	Sections 3.3.5.2.12, 4.3.7.2, PDSA - HLW Facility
HFP vessel overflow feature	SC-I	Sections 3.3.5.2.12, 4.3.7.3, PDSA - HLW Facility
[**HOLD**] Hydrogen mitigation system (air sparging and purging)	SC-I	Sections 3.4.2.1.1.3, 3.4.2.1.1.5, 4.3.8, 4.3.8.4, Appendix 4B, PDSA - HLW Facility and Section 16.4.2.8, BOD

Table 3–1 HCP and HFP Seismic Design Categories

Description	Seismic Category	Reference
Piping (includes inline components, such as valves, jumpers, and instrument lines) shall be seismic category SC-III, except the following: • HCP double-walled (coaxial) transfer piping (inner pipe): seismic category **SC-I** • HCP double-walled (coaxial) transfer piping (outer pipe): seismic category **SC-II** • GFR line outside the melter cave, up to and including the isolation valve and the GFR air purge line: seismic category **SC-I**	**SC-III**	Section 4.4.7, PDSA - HLW Facility Exceptions: • Table 3A-13, PDSA - PT Facility, • Section 4.3.15, PDSA - HLW Facility)
ADS pumps and discharge lines (HFP-PMP-00001 00002, 0001400015)	**SC-III**	Section 4.4.27, PDSA - HLW Facility
PAM instruments	**Seismic category designations per PAM report***	Safety Criterion 4.3-4, SRD
Safety instrument air supply lines, valves, and the ISA check valves	**SC-I**	Section 4.3.8.4, PDSA - HLW Facility

*24590-HLW-RPT-ENS-12-002, *HLW Preliminary Post Accident Monitoring Report*

Basis Discussion: Section 2.4.12 of 24590-WTP-PSAR-ESH-01-002-01, *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information* (PDSA – General) states the following: "All components and parts of the equipment that provide or contribute to the safety functions and accident monitoring functions, including equipment supports and anchorage, shall be qualified accordingly." This qualification ensures SSCs meet the designated seismic design requirements. Document 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II* (SRD), Safety Criterion 4.1-3 details the equivalence of the WTP seismic category to the seismic performance category of DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*. The SRD also states that SSCs designated as safety SSCs are to be designed to withstand the effects of NPH events (e.g., earthquakes, wind, and floods) without the loss of capability to perform specified safety functions. HFP vessel sparger design is on "**[HOLD]**" due to differences between 24590-HLW-PL-ENS-13-0001, Safety Design Strategy for the High-Level Waste Facility (SDS), and the PDSA - HLW Facility and the resolution is expected to eliminate sparging.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	**ENG/ SUP**	Analysis or testing performed on safety SSCs to verify capability to withstand seismic event.	This is expected to be documented in the EQPs.
R	**ENG**	Review of design to verify conformance to the results of the analysis requirements and to verify that the safety function, as established in the preliminary documented safety analysis (PDSA) is correctly reflected in the equipment qualification documents.	EQP is issued and verified to align with the PDSA/DSA. Review is expected to be joint effort between design agency and EQ group.

3.4.1.2.7 Durability of Equipment Subject to Decontamination

Requirement: The HCP and HFP equipment subject to decontamination agents such as frozen $C0_2$, Demineralized water, steam, and nitric acid, shall be capable of withstanding this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved. [Sections 9.1, 20.0, ORD] [Section 11.8.3.1, BOD]

Basis discussion: Equipment operating in a contaminated environment is monitored and, if necessary, decontaminated before maintenance. The specifications must convey that the equipment design accounts for these processes.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine which SSCs within the HFP/HCP system are subject to decontamination.	
R	ENG	Review design and vendor data to verify compliance with requirement to withstand decontamination without degradation to functionality.	

3.4.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

The WTP dangerous waste permit requirements for leak detection on the HCP transfer line from the PT Facility are included in the HLP SDD. The HCP and HFP systems sump leak detection requirements are included in HLW RLD SDD.

3.4.2.1 Safety Designations

Requirement: SSCs shall be designated as safety SSCs in accordance with Table 3–2 : [Safety Criterion 4.1-2, 4.1-3, 4.4-1, SRD] [Sections 3.4.1.1.5, 3.4.1.2.5, 3.4.1.7.2.5, 3.4.1.7.3.5, 4.3.7.1, 4.3.7.2, 4.3.7.3, 4.3.8, 4.3.15, 4.3.31, 4.4.4, 4.4.7, 4.4.16, 4.4.16.3, 4.4.23, 4.4.27.3, 4.4.30.3 PDSA - HLW Facility][Section 16.4.2.8, BOD].

Note: Safety instruments are addressed separately in Section 3.10.3.1.

Table 3–2 HCP and HFP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class	Safety Significant	References	
				Safety Class	Safety Significant
HFP vessels (HFP-VSL-00001/00005/00002/00006)	SC: Mitigates the consequences of a hydrogen explosion in HFP-VSL-00001/00005 and HFP-VSL-00002/00006 by providing confinement of radioactive materials. Reduces the probability of a radioactive material release from HFP-VSL-00001/00005 or HFP-VSL-00002/00006 by providing confinement of waste during and after a seismic event. SS: Reduces the probability of a radioactive material release by providing confinement.	Yes	Yes	Section 4.3.7.1, PDSA - HLW Facility	Section 4.4.16, PDSA - HLW Facility
HFP vessel overflow feature	SC: Reduces the probability of an over pressurization by providing an exhaust path. Reduces the probability of a hydrogen explosion by providing an exhaust path should the HOP/PVV become unavailable. Reduces the probability of a hydrogen explosion by ensuring an adequate headspace volume to dilute hydrogen. SS: Reduces the probability of vessel over pressurization and failure by providing an exhaust path.	Yes	Yes	Section 4.3.7.3, PDSA - HLW Facility	Section 4.4.16.3, PDSA - HLW Facility

Table 3–2 HCP and HFP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class	Safety Significant	References	
				Safety Class	Safety Significant
[**HOLD**] Glass former feed line isolation valve interlocks and air purge	SC: Reduces the probability of a facility worker being exposed to radioactive material by closing the glass former isolation valve upon indication of potential for loss of confinement. SS: Reduces the probability of radiological exposure to a facility worker by closing the glass former isolation valve upon indication of potential for loss of confinement. Reduces the probability of radiological exposure to a facility worker by purging the glass former feed line	Yes	Yes	Section 4.3.15, PDSA - HLW Facility	Section 4.4.23, PDSA - HLW Facility
[**HOLD**] Hydrogen mitigation system (air sparging)	Reduces the probability of a hydrogen explosion in vessels HFP-VSL-00001/00005 or HFP-VSL-00002/00006 by mixing the waste upon failure of an agitator.	Yes	No	Section 4.3.8, PDSA - HLW Facility	N/A
[**HOLD**] Hydrogen mitigation system (air purging)	Reduces the probability of a hydrogen explosion in vessels HFP-VSL-00002/00006 or HFP-VSL-00001/00005 by providing safety purge air on loss of normal purge air.	Yes	No	Section 4.3.8, PDSA - HLW Facility	N/A
Air amplifier system	Reduces the probability of radioactive material spreading to C2 or C3 zones by drawing the HFP-VSL-00001/00005 and HFP-VSL-00002/00006 headspace atmospheres into the melter cave following a seismic event.	Yes	No	Section 4.3.7.2, PDSA - HLW Facility	N/A
[**HOLD**] MFPVs (HFP-VSL-00001/00005) High-high liquid level feed diversion valve interlock	Reduces the probability of the MFPVs (HFP-VSL-00001/00005) being overfilled by terminating feed transfer to the vessel when the high-high level setpoint is exceeded.	No	Yes	N/A	Sections 4.4.4, 3.4.1.2.5, PDSA - HLW Facility

Table 3–2 HCP and HFP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class	Safety Significant	References	
				Safety Class	Safety Significant
Piping (including jumpers and inline components): ○ Piping from MFPVs (HFP-VSL-00001/00005) to the autosampler enclosure ○ Piping from MFPVs (HFP-VSL-00001/00005) to MFVs (HFP-VSL-00002/00006) ○ Piping from MFVs (HFP-VSL-00002/00006) to the autosampler enclosure ○ Piping from MFVs (HFP-VSL-00002/00006) to the melters ○ Flapper valves on the HFP overflows (overflows with flapper valves are SC) ○ Secondary offgas piping ▪ Note: Service and cooling piping lines are not SS.	Reduces the probability of a facility worker receiving an exposure that exceeds exposure standards. Reduces the probability of a radioactive material release by providing confinement. The piping/tubing in contact with waste (including safety air tubing as applicable) reduces the probability of a failure by providing confinement during and after multiple hydrogen explosions.	No	Yes	N/A	Sections 3.4.1.1.5, 4.4.7, 4.4.27, PDSA - HLW Facility

Table 3–2 HCP and HFP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class	Safety Significant	References	
				Safety Class	Safety Significant
Coaxial piping (SC inner coaxial piping and SS outer coaxial piping) ○ HLW concentrate receipt piping for transfers from the PT Facility ○ Melter cave cross-connect piping	Reduces the probability of a facility worker receiving an exposure that exceeds exposure standards. SC: Inner Pipe prevents a release of a radioactive and chemically hazardous material release by providing primary confinement. SS: Outer Pipe prevents a release of a radioactive and chemically hazardous material release by providing secondary confinement. The piping/tubing in contact with waste (including safety air tubing as applicable) reduces the probability of a failure by providing confinement during and after multiple hydrogen explosions. The coaxial pipe prevents the introduction of non-Newtonian waste solution into RLD-SUMP-0001. Preventing non-Newtonian waste from entering RLD precludes a hydrogen explosion in RLD-VSL-00008.	Yes	Yes	Section 4.3.31	Section 4.4.7.2
ADS pumps and discharge lines	Reduces the probability of a release by providing confinement during a hydrogen explosion.	No	Yes	N/A	Section 4.4.27.3 PDSA - HLW Facility
Mechanical agitators	Reduces the probability of a radioactive material release by agitator being designed so failure resulting in vessel impact will not breach the vessel.	No	Yes	N/A	Section 4.4.16.2.1, PDSA - HLW Facility

Basis Discussion: To ensure safety SSCs meet the design functions, Safety Criterion 4.4-1 of the SRD states: "Safety structures, systems, and components designated as SC and SS shall be designed and qualified to function as intended in the environments associated with the events for which they are intended to respond." The portions of this requirement on hold are the Glass former feed line isolation valve, Hydrogen mitigation system (air sparging), and the MFPV high liquid level feed diversion valve interlock. The sparger design is on "[**HOLD**]" due to differences between 24590-HLW-PL-ENS-13-0001, Safety Design Strategy for the High-Level Waste Facility (SDS), and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The MFPV high liquid level interlock is on hold due to differences between the SDS and PDSA for how the interlock is actuated. Also, the glass former feed line isolation valve interlock designation requirement is on [**HOLD**] due to designation as both SC and SS but not meeting single failure criteria (see Sections 3.10.2.1.1 and 3.10.2.2.2). Designation of the GFR isolation valve as SC is not required to protect the facility worker.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of design to verify safety designations as identified in the equipment qualification datasheet.	EQP is issued and verified to align with the PDSA/DSA. Review is expected to be joint effort between design agency and EQ group.

3.4.3 System Interface Requirements

Requirements associated with specific system interfaces are discussed in the subsequent requirement sections titled "System Interface Requirements." The HCP and HFP system interfaces are listed in Table 3–3.

Table 3–3 HCP and HFP System Interfaces

System Locator	System Name	Nature of Interface
ASX	Autosampling System	ASX-SMPLR-00029 and ASX-SMPLR-00042 receive samples from MFPVs to characterize the batch waste.
C5V	C5 Ventilation System	Provides ventilation of the melter cave to remove headspace gas vented by the HFP vessel air amplifiers or overflow features when the HOP/PVV is unavailable.
DIW	Demineralized Water System	Supplies demineralized water via ASX and PWD to MFPVs and MFVs for D&D washdowns and concentrate dilution, to flush transfer lines and spargers, to prime sample/transfer, and to flush ADS pumps.
GFR	Glass Formers Reagent System	GFR-TK-00025 and GFR-TK-00031 supply glass formers to MFPVs.
HCP	HLW Concentrate Receipt Process System	Supplies HLW concentrate to MFPVs from PT HLP.
HFP	HLW Melter Feed Process System	Receives feed concentrate from HCP.
HLP	HLW Lag Storage and Feed Blending Process System	HLP-VSL-00028 supplies HLW concentrate to MFPVs via PT HLP and HCP transfer piping.
HMP	HLW Melter Process System	HMP-MLTR-00001 and HMP-MLTR-00002 receive melter feed from MFVs.
HOP	HLW Primary Offgas System	Negative headspace pressure is maintained in the HFP vessels by the PVV and HOP systems.

Table 3–3 HCP and HFP System Interfaces

System Locator	System Name	Nature of Interface
HPS	High Pressure Steam System	Supplies steam to the steam ejectors in the HFP vessels.
HSH	HLW Melter Cave Support Handling System	Provides mechanical handling components used to remotely remove and replace all maintainable or replaceable HFP equipment and components within the melter caves.
ISA/ Safety ISA	Instrument Service Air System	The safety ISA provides air for vessel sparging/purging, GFR line purging, air supply to the air amplifiers (when activated), as well as motive force to operate pneumatically operated safety valves. (These functions may be supported by non-safety ISA but must transition to safety ISA upon loss of the non-safety source) The non-safety ISA supplies instrument air to non-safety HFP instruments, control valves, and ADS pumps.
LVE	Low Voltage Electrical System	Supplies electrical power to the HFP equipment and instruments.
NAR	Nitric Acid Reagent System	Supplies nitric acid reagent for decontamination activities.
PCJ	Process Control System	Provides operational monitoring and control of the process and equipment. Components without SC/SS functions are controlled from the PCJ.
PCW	Plant Cooling Water System	Supplies cooling water to the HFP vessel cooling jackets.
PPJ	Programmable Protection System	Provides automatic safety control functions.
PVV	Process Vessel Vent Exhaust System	Vessel vent header receives vents from MFPVs and MFVs. Negative headspace pressure is maintained in the HFP vessels by the PVV and HOP systems.
PWD	Plant Wash and Disposal System	Supplies demineralized water to HFP vessels for washdowns, concentrate dilution, to prime sample/transfer pumps. The PT Facility's PWD-VSL-00043 receives flush water from the HLW concentrate transfer line from PT HLP to MFPV.
RLD	Radioactive Liquid Waste Disposal System	RLD-VSL-00008 receives D&D washdowns MFPVs and MFVs.
UPE	Uninterruptible Power Electrical System	Supplies emergency back-up power for Safety SSCs requiring electrical power. This includes the feed transfer diversion interlock and the PPJ control functions for air amplification and hydrogen mitigation.

3.4.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.4.4.1 Remotely Maintainable or Replaceable Equipment and Components

Requirement: The HFP maintainable or replaceable equipment and components shall be designed with remote handling features capable of being removed and re-installed via interface with the HLW melter cave support handling system (HSH), as shown in Table 3–4. [Sections 5.2, 6.2, 8.1.3, 9.1, 14.1, 14.2, 14.10, ORD][Sections 6.7, 8.1.2, 9.12, 9.4.2, 11.3.2, 11.3.2.3, 11.4.1, 11.4.4, 11.5.1, 11.7.4, 11.8.3.1, 12.6.3, BOD].

Table 3–4 Remotely Maintainable or Replaceable Equipment and Components

Equipment/Component Description	Remotely Removable and Replaceable
MFPVs	Yes
MFVs	Yes
Mechanical Agitators	Yes
Sample/Transfer Pumps	Yes
ADS Pumps	Yes
Demisters	Yes
Air Amplifiers	Yes
Steam Ejectors	Yes
Overflow Feature/Flapper Valves	Yes
Jumpers (Mechanical, Instrument Air, and Electrical)	Yes
Inline Components (valves/instruments)	Yes*

*This may be accomplished by removing and replacing the jumper section including the inline component (valve/instrument).

Basis Discussion: Remote maintenance operations generally are to be performed in the designated maintenance area. In-cave equipment disassembly, removal to maintenance area, and/or replacement is accomplished by local remote handling equipment or by remote handling equipment in dedicated maintenance areas or caves. In general, process systems and equipment within cells or caves that could fail during operations are designed for safe recovery, replacement, or redundancy. Remote handling features help to facilitate interfacing with equipment or components when using remote handling equipment such as in-cave cranes, power manipulators, or master-slave manipulators.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of design using a software program to verify that all replaceable components are remotable.	May be documented in an assessment/evaluation. Recommend using a software program such as "IGrip" (or similar).
T	**SU/COM**	Demonstrate remotability in accordance with 24590-WTP-PL-RACT-RT-0001, *WTP Remotability Verification Plan.*	Physical demonstration

3.4.4.2 Redundancy

Requirement: The system design shall incorporate redundant waste transfer capability necessary to achieve the throughput glass production rate. The HFP design shall include a coaxial cross-connection between the two melter trains that allows contents from the MFPV or MFV in one melter train to be transferred to the corresponding vessel in the other melter train. [Sections 6.3.3, 11.3.2, 11.4.2, BOD] [Section 14.3, ORD][Sections 4.3.31, 4.4.7.2, PDSA- HLW Facility] (F.1).

Basis Discussion: This requirement is decomposed from the BOD and ORD requirements to provide redundancy. The HFP/HCP piping has been designed to incorporate redundancy for process flows. The implementation of a melter feed cross-connection allows additional flexibility and supports a feed-forward strategy (refer to Section 4.1.1, 24590-HLW-TB-ENG-13-0002, *Engineering Design Decision for HLW HFP*). In general, process systems and equipment within cells or caves that could fail during operations are designed for safe recovery, replacement, or redundancy. The need for redundancy has been evaluated in the basis of performing a failure modes, effects, and criticality analysis. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify the capability exists to transfer HFP vessel contents between the respective MFPVs and MFVs in both melter trains.	

3.4.4.3 Redundant Waste Transfer Supply and Flush

Requirement: The design shall provide an alternate flush method from the HLW Facility to the PT Facility to support a single PT to HLW waste transfer line configuration. [Sections 6.2.1, 11.3.2, 11.4.2, BOD] [Sections 14.3, 20.0, ORD] (B.1).

Basis Discussion: During normal operations, each MFPV has 2 dedicated lines which permit transfer of concentrated waste from the PT facility to the HLW MFPVs through 1 of the 2 dedicated transfer lines. Following a normal transfer, a flush is sent, from the PT facility, into the MFPV through the same dedicated transfer line. Following a valve reconfiguration, additional flushing from PT is directed towards the HLW facility through the first transfer line but recirculates back to PT through the second dedicated transfer line. The second dedicated transfer line is primarily used for flush return to the PT facility.

In the event that the first dedicated transfer line is lost (plugging or other failure mode) the secondary transfer line is reconfigured to transfer waste from the PT facility to the MFPV. Following waste transfer, only initial flushes may enter the MFPV due to batch volume constraints. As directed by this requirement, remaining flushes will be directed from the HLW facility back to the PT facility since the normal recirculating flush capability will be lost.

Flushing controls of the transfer line will help to remove waste and prevent plugging (refer to Section 4.1.4 of 24590-HLW-TB-ENG-13-0002 and Section 4.10.3 of 24590-HLW-ES-ENG-13-003, *Risk Reduction Study for the High Level Waste (HLW) Facility: Failure Modes, Effects, and Criticality Analysis (FMECA), In-Service Inspection (ISI), and Plugging*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify redundant transfer capability of HLW concentrate from the PT Facility HLP to the HLW MFPV.	
R	ENG	Review of the design to verify the capability to flush the HLW concentrate transfer lines from the HLW Facility to the PT Facility, using water from the HLW Facility.	

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/COM	Demonstrate the capability to flush the HLW concentrate transfer lines from the HLW Facility to the PT Facility, using water from the HLW Facility.	

3.4.4.4 Prevent Out-of-Specification Batch Transfers to RLD System

Requirement: The piping design shall include provisions to prevent out-of-specification batch transfers from the HFP vessels to the RLD system. Transfers from the HFP vessels to the RLD system shall only be permitted for vessel decommissioning purposes and normal vessel washings shall be processed forward to the melters using a feed forward strategy. [Section 7.1, ORD] (H.1).

Basis Discussion: The HFP design will accommodate a feed-forward operational strategy and include design features to impede transfers of hydrogen generating waste to the RLD system. Section 5.6.35 of 24590-WTP-PSAR-ESH-01-002-04, *Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Specific Information* (PDSA – HLW Facility) states the following: "Steam supply to the HFP vessel steam ejectors is isolated (i.e. welded end connections) so that there is no connection between there ejectors and the steam supply." The design no longer allows transferring out-of-specification batches from the HFP vessels to the RLD during plant operations to remove a non-Newtonian hydrogen generation source to the RLD. The steam ejector and jumpers are only to be installed after decontaminating the HFP vessels, which requires the ability to minimize the residual heel volume and transfer the rinse/flush liquid to the RLD. In addition, removal of the normal transfer path of HFP streams to RLD (and back to PT) required by section 7.1 of the ORD has been evaluated as acceptable in accordance with exemption 24590-WTP-ORDX-OP-15-0037. The ORD exemption was documented as required by CR 24590-WTP-GCA-MGT-15-01057. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify that the steam ejector and jumpers, used to support transfers from the HFP vessels to the RLD, are not normally installed and include a welded end connections.	
R	ENG	Review of the design to verify out-of-specification waste may be processed by the melters utilizing a feed-forward operational strategy.	

3.4.4.5 Startup Testing and Commissioning

Requirement: The system design shall accommodate provisions, as necessary, to support startup and commissioning testing as identified in Appendix A. [Section 11.4.7, 11.5.1, BOD][Section 9.1, ORD].

Basis Discussion: Additional nozzles, branch lines, removable spools or other provisions needed to support identified testing are to be accommodated in the design, as jointly determined by the design agency, Startup and Commissioning during the design development and review process, with consideration given to the tests and demonstration activities required for requirement verification specified in Appendix A. This may include, but is not limited to, provisions to support the introduction or removal of fluids, gases, reagents or simulants; or the availability of special test ports, sampling ports, or temporary instruments or instrument lines.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the HLW HFP/HCP system to determine the provisions needed to support tests/demonstrations to be performed during startup and commissioning.	May be documented in an assessment/evaluation. Startup and Commissioning to participate in the assessment.
R	ENG	Review design to verify provisions in the design account for tests/demonstrations to be performed during startup and commissioning.	May be documented in an assessment/evaluation report. Startup and Commissioning to participate in the assessment.

3.4.4.6 MFPV Sump Transfer Route

Requirement: [**HOLD**] The HFP system design shall incorporate features to receive and reprocess recovered spilled material from sumps HOP-SUMP-00003/00008, HPH-SUMP-00003/00004, HCP-SUMP-00001, HSH-SUMP-00003/00007, and HFP-SUMP-00002/00005. (A.1, A.1.1).

Basis Discussion: The sump transfer route was developed due to concerns with Non-Newtonian waste entering the RLD system and accumulation of hydrogen gases which could cause a hydrogen explosion. PDSA- HLW Facility Section 3.3.3.6.1, RLD Hazards Analysis, states "sump transfer route- prevents an H_2 explosion in the RLD-VSL-00008 by removing all routes of adding non-Newtonian waste." As such, the HFP vessel sumps were re-routed from RLD to the MFPVs. This requirement and design associated with sump transfers into the HFP process stream are on [**HOLD**] pending PDSA incorporation of section 4 requirements to prevent high solids waste in sumps from being sent to the RLD system. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the capability exists to transfer recovered spilled material from the sumps HOP-SUMP-00003/00008, HPH-SUMP-00003/00004, HCP-SUMP-00001, HSH-SUMP-00003/00007, and HFP-SUMP-00002/00005.	May be documented in an assessment/evaluation.

3.4.4.7 Equipment Tolerances

Requirement: Systems and equipment requiring remote installation and maintenance shall have tolerances specified in their design and be as-built with sufficient precision to provide for the ability to remotely install, connect, disconnect, and reconnect all replaceable components. [Section 14.10, ORD].

Basis Discussion: As-builts of remote equipment and permanent plant interfaces for the remote equipment provide the ability to remotely install, connect, disconnect, and reconnect all replaceable components.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review supplier fabrication and installation drawings to verify compliance with dimensions and tolerances specified in the purchase order	Accomplished during review of submitted G-321-E documents
I	SQR	Inspect equipment to verify dimensions conform to the provided as-built drawings (within established tolerances).	This is expected to be accomplished via the MAP.
I	CON	Take as-built measurements of installed equipment and verify compliance with dimensions and tolerances specified in supplier installation drawings and manuals	Record in equipment inspection record.

3.5 Vessel Requirements

3.5.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.5.1.1 Vessel Design and Operating Conditions

3.5.1.1.1 Size (Batch Volume Capacity)

Requirement: The HFP vessels shall each be designed for a minimum batch volume to support 100% capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day). The stated vessel maximum capacities in the Dangerous Waste Permit shall be aligned with the maximum capacities of the procured vessels. [Section 6.3.3, BOD] [Section C.7(b)(3), No. DE-AC27-01RV14136] [Section C.6 - Standard 3: (c)(4), No. DE-AC27-01RV14136](A.1, A.2, M.1.1).

Basis Discussion: The design throughput (processing) capabilities for the HCP and HFP systems are defined in Section 6.3.3 of the BOD. Software models are used to validate the design throughput capacity is met by the designed systems, inclusive of treatment processes, individual system and component capabilities, and equipment reliability and maintainability inputs. The HFP is designed to accommodate the receipt and treatment of specific waste volumes, using batch processing capabilities, to meet the design throughput requirements. The throughput rates are a function of the feed characteristics in a given batch volume. Batch volume and nominal transfer rate are used as inputs in the overall throughput analysis to ensure HCP and HFP systems operations are designed to support the 100 % capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day), as stipulated in the WTP Contract. As stated in the BOD, the 5,500 gallon HFP vessel design batch volume is a key design feature assumed in modeling and ORP concurrence is required before the capability can be reduced in design.

The maximum batch volume of 5500 gal will allow for at least 300 gal of reserve volume for adjusting the batch composition using additional glass formers (up to 3800 pounds) (refer to Section 8.1 of 24590-HLW-ES-PR-04-0001, *HLW Melter Feed and Feed Preparation Vessel Utilization and Time Cycle Evaluation*). The vessel sizing calculation is required per WTP Contract, Section C - Standard 3: (c)(4), which states, "Calculations for Equipment Sizing: The calculation and technical basis for the capacity of major vessels, equipment, and piping shall be provided."

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the HFP vessels to determine the minimum batch volume required to satisfy facility throughput.	
R	ENG	Review of design to verify conformance to the results of the analysis.	
R	ENG	Review design to verify vessel maximum capacities conform to the stated values in the permit.	Verification must preceded receipt of waste.

3.5.1.1.2 Temperature

Requirement: The HFP vessel design shall provide the capability to maintain the process fluid temperature between the vessel upper and lower design temperature limit and/or upper temperature limit established to preclude cavitation in the sample/transfer pumps. [Sections 6.1, 6.4, BOD](M.1.1).

Basis Discussion: The HFP vessels are cooled to achieve required processing conditions by removing heat generated from the radioactive decay of the vessel contents and mechanical agitator shaft work. Section 6.4 of the BOD states the secondary cooling loop is provided to equipment in contact with radioactive material.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the upper and lower design temperature limit for the vessels inclusive of any temperature limit to preclude cavitation of the sample/transfer pumps.	
A	ENG	Perform an analysis to document that the combined HFP/PCW design is capable of maintaining the required temperature range.	
R	ENG	Review of HFP vessel design, including interface with PCW system, to verify conformance to the results of the analysis.	

3.5.1.1.3 Pressure

Requirement: The HFP vessels shall be designed to at least the maximum negative pressure generated by the HLW melter offgas treatment process system (HOP). (M.1.1).

Basis Discussion: The HFP vessels are designed to withstand the maximum negative pressure vacuum created by the HLW HOP booster and stack fans. The HFP vessels are designed to withstand the maximum positive pressure before the overflow feature opens. Note: Section 7.6 of calculation 24590-HLW-MVC-HFP-00001determined the design operating pressure range to be between 1.6 in. water gauge and -151 in. water gauge.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum negative pressure and verify the design can withstand at least that pressure.	Refer to ASME BPVC Section VIII, Division 1 calculation, documented in DVR.
R	ENG	Review of design to verify conformance to the results of the analysis.	Documented in DVR.

3.5.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.5.2.1 Vessel Overflow Feature Design

3.5.2.1.1 Unobstructed Flow Path

Requirement: Each HFP vessel shall include an overflow feature designed to provide an unobstructed escape flow path for liquids or gases during abnormal operating conditions (e.g., loss of negative pressure or vessel contents in excess of operational level limits). Overflowed liquid shall be directed towards the melter cave sump. [Sections 3.3.5.1.11, 3.3.5.2.3, 4.3.7.3, 4.4.16.3, 5.6.2, PDSA - HLW Facility][Section 6.7.5, BOD](C.1).

Basis Discussion: The HFP vessel overflow feature prevents excessive airflow into the vessel through the engineered vessel overflow during normal operations, without preventing the vessel overflow from providing required safety functions (Section 3.1.3, 24590-HLW-3PS-HFP-T0003, *Engineering Specification for High Level Waste Melter Feed System Demisters, Air Ejectors and Overflow Flapper Valves*). The overflow feature is designed to maintain the headspace volume in HFP vessels. The headspace volume in the HFP vessels is maintained by designing the overflow feature to account for abnormal operating conditions, such as from operator error or equipment malfunction, that result in positive pressure or vessel content levels in excess to normal operations. The overflow feature provides a pathway for the vessel liquids and headspace atmospheres to exit the HFP vessels. Contained within the overflow is an opening mechanism which opens upon differential pressure across the disc to create the unobstructed path. This line is designed to prevent the buildup of material that could cause blockages. The overflow feature directs liquid that overflows from the HFP vessels to the respective melter cave sump and provides a backup exhaust path should the HOP and process vessel vent exhaust system (PVV) fail.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of HFP vessel design to verify incorporation of an overflow feature which directs overflows towards a melter cave sump.	Documented in DVR.

3.5.2.1.2 Operability

Requirement: The HFP vessel overflow feature shall be designed to prevent its opening mechanism from fully sealing closed. [Sections 4.3.7.3, 5.6.2, PDSA - HLW Facility](C.1).

Basis Discussion: The overflow feature is to be designed to not fully close during normal operations to prevent accumulation of solids around the overflow feature opening mechanism's sealing surfaces that could cause it to adhere closed to the vessel. This could result in the overflow feature failing to open under abnormal operations.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of HFP vessel design to verify the opening mechanism of the overflow feature will not fully close.	Documented in DVR.

3.5.2.1.3 Size

Requirement: The HFP vessel overflow feature design shall be sized to at least meet the maximum in-flow rate at a bounding design rheology, while maintaining a minimum vapor headspace to allow for hydrogen dilution and prevent liquid flooding into the vessel ventilation header. [Sections 3.3.5.1.11, 4.3.7.3, 4.4.16.3, 5.6.2, PDSA - HLW Facility][Section 6.7.5, BOD](C.1).

Basis Discussion: The overflow feature reduces the potential for a hydrogen explosion by ensuring an adequate headspace volume to dilute hydrogen generated in the HFP vessels.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the overflow feature is sized to discharge the maximum inflow rate at the bounding design rheology to maintain the minimum vapor headspace to allow hydrogen dilution and prevent liquid flooding into the vessel ventilation header.	Documented in DVR.
R	ENG	Review of design to verify conformance to the analysis results.	Documented in DVR.

3.5.2.2 Waste Acceptance Impacting Qualification for MFPVs

Requirement: The MFPVs shall have an internal geometric configuration and baffle design in accordance with the waste acceptance impacting (WAI) requirements. [Section 3.1, 4.1.2.2, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] (A.2).

Basis Discussion: The internal geometric configuration is designed to increase the effectiveness of the agitator mixing and provide homogenization of the waste. The HLW melter feed prep vessel's internal geometric configuration and baffle design is deemed WAI (24590-HLW-WSF-ENG-07-005, *WAI Screening of HFP Sample Loop Flow Meter*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify conformance to the WAI dimensional requirements.	Documented in completed 24590-HLW-WIQP-MS-09-0001, *HLW HFP Feed Preparation Vessels*

3.5.2.3 Hydrogen Explosion

Requirement: The HFP vessels shall maintain integrity following a pressure front generated by an internal hydrogen explosion. [Sections 4.3.7.1, 4.3.7.1.1, 4.3.7.1.3, PDSA - HLW Facility].

Basis Discussion: The functional requirement in Section 4.3.7.1 of the PDSA - HLW Facility states, "Vessels maintain integrity following pressure front generated by a hydrogen explosion." This requirement has been established due to the potential for hydrogen generation within the waste contents. In addition to this requirement, the HFP vessels are designed with safety controls and design features to prevent accumulation of hydrogen in excess of the lower flammability limit (LFL) thereby preventing a hydrogen explosion from occurring (reference 3.5.3.7.1). They are also designed in accordance with ASME BPVC Section VIII, Division 1.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to document the HFP vessels maintain integrity after a hydrogen explosion.	Documented in DVR.
R	ENG	Review of design for conformance to the analysis results.	Documented in DVR.

3.5.3 System Interface Requirements

3.5.3.1 PT Facility HLP - Receive HLW Concentrate

Requirement: [**HOLD**] The MFPVs shall interface with the HCP transfer line to receive HLW concentrate from the PT Facility HLP at a minimum required transfer rate to support 100% capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day). [Section 6.3.1, BOD] [Sections 4.4.7, 4.4.7.2, PDSA - HLW Facility] [Section C.7(b)(3), No. DE-AC27-01RV14136] (A.1).

Basis Discussion: The design throughput (processing) capabilities for the HLP, HCP and HFP systems are defined in Section 6.1.3 and 6.3.3 of the BOD. Software models are used to validate the design throughput capacity is met by the designed systems, inclusive of treatment processes, individual system and component capabilities, and equipment reliability and maintainability inputs. The HFP is designed to accommodate the receipt and treatment of specific waste volumes, using batch processing capabilities, to meet the design throughput requirements. The throughput rates are a function of the feed characteristics in a given batch volume. Batch volume and nominal transfer rate are used as inputs in the overall throughput analysis to ensure HCP and HFP systems operations are designed to support the 100 % capacity melter throughput for glass production of 3.75 metric tons of glass (MTG)/day/melter (total of 7.5 MTG per day), as stipulated in the WTP Contract. As stated in the BOD, the PT facility transfer rate to the HLW HCP piping is considered a key design feature assumed in modeling and ORP concurrence is required before the capability can be reduced in design.

The HCP transfer line provides the interface between the PT Facility and HLW Facility to support the glass throughput production. Minimum transfer rate and line velocity values to support glass production and to

preclude line plugging will be provided in the PT Facility HLP SDD. The HCP and HFP systems need to support the HLP transfer rate. Section 6.3.1 of the BOD includes a nominal transfer rate of 55 gpm, but Section 7.1 of calculation 24590-PTF-MPC-HLP-00016, *Pump and Line Sizing Calculation for Pumps HLP-PMP-000019A/B* determined the minimum transfer rate to be 56 gpm. This requirement and design associated with receiving waste from PT (HCP piping) are on "[**HOLD**]" until the BOD is updated to reflect the bounding minimum required transfer rate.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to determine the transfer rate of concentrate the HCP and HFP systems must receive from the PT facility to support HLW facility throughput.	
R	**ENG**	Review design to verify the HCP transfer line provides a connection between the PT Facility HLP and the HLW Facility MFPVs.	
R	**ENG**	Review the PCJ design to verify the existence of a control scheme that allows HLW concentrate transfer from the PT Facility HLP to the MFPV.	

3.5.3.2 Glass Former Reagent System - Glass Formers

Requirement: The HFP system shall interface with the GFR system to receive gravity flow of glass formers into the MFPV. [Section 6.1.3, BOD][Sections 2.2, 3.2, 4.1, IHLW Waste Form Compliance Plan for WTP](A.4).

Basis Discussion: Proper proportions of various glass formers will be prepared, mixed, moistened, added to the HLW concentrate, and mixed to prepare HLW feed material.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of design to verify the MFPV interfaces with GFR to receive the glass formers.	
R	**ENG**	Review the PCJ design to verify the existence of a control scheme that allows transfer of glass formers from the GFR blend vessel.	

3.5.3.3 Melter Feed Preparation Vessel - Transfer to Melter Feed Vessel

Requirement: The MFPVs shall interface with the MFVs to transfer the mixed and compliant melter feed batch for staging prior to glass production. [Sections 2.2, 3.1, 3.2, IHLW Waste Form Compliance Plan for WTP](A.7, A.8).

Basis Discussion: The MFPVs transfer sampled and approved waste to the MFVs for continuous transfer to the melters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the transfer line interfaces between the MFPV and MFV to receive the melter feed.	

3.5.3.4 Melter Feed Vessel - Transfer to Melter

Requirement: The MFVs shall interface with the HLW melters to transfer the mixed melter feed batch for glass production. [Sections 2.2, 3.1, 3.2, IHLW Waste Form Compliance Plan for WTP](A.10).

Basis Discussion: Waste within the MFVs is transferred by the ADS pumps to the melters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the transfer line interfaces between the MFVs and melters to receive the melter feed.	

3.5.3.5 Plant Wash and Disposal System - Vessel Wash Water

Requirement: The HFP vessels shall interface with the PWD to receive demineralized water, with or without nitric acid, to wash and decontaminate the vessels and internals. [Sections 5.2, 14.1, 20.0, ORD](D.1, D.2).

Basis Discussion: Internal decontamination by-products are processed forward to the melters using the feed-forward strategy.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify the interface between the PWD and NAR systems and HFP vessels to receive demineralized water and nitric acid for washing the vessels.	

3.5.3.6 Vessel Cooling

Requirement: The HFP vessel design shall be capable of being cooled and include any required system interfaces. (K.1, M.1.1).

Basis Discussion: The HFP vessels are cooled to remove heat generated by mixing and radioactive decay to maintain temperatures within the ranges stipulated in requirement 3.5.1.1.2.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to document the HFP vessels are capable of being cooled and maintain temperature within the ranges stipulated in requirement 3.5.1.1.2.	
A	ENG	Perform an analysis to determine the water demand required to satisfy HFP vessel cooling and determine if the interfacing cooling system can supply the required demand.	
R	ENG	Review of design to verify conformance to the analysis results.	

3.5.3.7 Process Vessel Vent Exhaust and HLW Melter Offgas Treatment Process Systems - Vessel Ventilation

3.5.3.7.1 Hydrogen Mitigation

Requirement: The HFP vessels shall interface with the PVV systems to remove hydrogen from the vessel headspace during normal operations. [Sections 4.3.8.3.1, 4.3.8.3.2, PDSA - HLW Facility] [Section III.10.E.9.c.xi., Dangerous Waste Portion of RCRA Permit] (J.1).

Basis Discussion: The PVV and HOP systems reduce the potential for explosion by removing hydrogen from the vessel headspace to below the LFL. DWP condition III.10.E.5.1 requires the H_2 to be maintained below the LEL which normally is slightly less stringent than the LFL.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to document the PVV system capability to remove hydrogen from the vessel headspace during normal operations.	
R	ENG	Review of the system design to verify the interface with the PVV system to remove hydrogen from the HFP vessel headspace.	Documented in DVR.

3.5.3.8 High Pressure Steam - Steam Ejectors

Requirement: The HFP vessel design shall interface with the high pressure steam system (HPS) system to receive steam for the steam ejectors to transfer the vessel washwater (up to 5% solids) to the RLD system. (H.1).

Basis Discussion: The steam ejectors provide a method to transfer vessel washings to support vessel decontamination and decommissioning (D&D). The steam ejectors are physically separated from the HFP vessels during normal operations to prevent transfer of non-Newtonian waste from entering the RLD system. Decision paper 24590-HLW-TB-ENG-13-0001, Engineering Design Decision for RLD, identifies the proposed operational restrictions to the transfer path between the HFP vessels and RLD except for vessel decommissioning. PDSA Appendix 4B, Hydrogen Mitigation for hydrogen in Piping and Ancillary Vessels, states: "steam ejectors in the

HLW HFP vessels are not used on a routine basis and are not installed until needed" and "ejectors will be employed for final cleanup of vessels prior to replacement." The reduction in maintenance resulting from use of ejectors versus pumps is an ALARA feature.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify capability of the steam ejectors to transfer washwater.	
R	ENG	Review of design to verify incorporation of the analysis	
T	SU/COM	Demonstrate the steam ejectors can transfer washwater from the HFP vessels to the RLD (RLD-VSL-00008).	

3.5.3.9 Autosampling System - Recirculate HFP vessel contents for sampling

Requirement: Each HFP vessel design shall include a recirculation loop to the ASX system for sampling. [Sections 3.1, 4.1, 6.4, IHLW Waste Form Compliance Plan for WTP] (A.3, A.6).

Basis Discussion: The HFP recirculation loop includes an ASX autosampler providing the capability to extract samples for analysis from the HFP vessels. Samples are collected before and after the addition of glass formers in the MFPV. A glass formulation algorithm will be used to calculate the required glass forming chemicals to be added to the MFPV. There will not be routine sampling of the MFV but sampling capability will be provided. The melter feed is transferred from the MFV to the melter where it is processed into glass and subsequently poured into canisters. Requirement 3.4.1.1.3, Minimum Sampling Transfer Rate, includes a verification test to verify the sample/transfer pumps are capable of providing a minimum transfer rate to the ASX.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify the sample lines provide the capability to recirculate sample fluid between the ASX and each HFP vessel.	

3.5.3.10 High-Level Waste Melter Feed Process System Vessels Receive Autosampling System Enclosure Drain Lines

Requirement: [**HOLD**] The HFP vessel design shall interface with the ASX drain lines from the ASX enclosures to receive overflowed liquid. (A.3.1, A.6.1).

Basis Discussion: Autosamplers ASX-SMPLR-00029/0042 drain overflowed liquid back to the HFP vessels. This requirement and the ASX autosampler drain line interface with the HFP system are on "[**HOLD**]" because the hazards analysis and PDSA have not yet been updated with section 4 requirements to reflect the information in the SDS. Section 3.3.3.6.1 of the PDSA - HLW Facility currently states that the ASX drain lines are routed to vessel RLD-VSL-00008 however, the PDSA requires section 4 requirements for the ASX drain lines to drain to

the MFPVs. The requirement reference will be updated to include the PDSA section reference after the PDSA is updated to align with the SDS.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the vessel design to verify the ASX enclosure drain lines are connected to the HFP vessels.	

3.5.3.11 Plant Wash and Disposal System - Dilute vessel contents

Requirement: The HFP vessels shall interface with the PWD to receive demineralized water for washing the vessel internals and diluting the vessel contents. (D.1.3, H.1).

Basis Discussion: The HFP vessel contents are diluted with demineralized water and cleaned prior to removal using the steam ejectors for D&D or maintenance and replacement activities. Diluting the waste also enables the steam ejectors to work more efficiently. Per Section 3 of calculation 24590-HLW-M6C-HFP-00002, *HFP-EJCTR-00001, -00002, -00004 and -00005 Steam Ejector Sizing Calculation* the steam ejectors are only capable of lifting a bounding/maximum solids percentage of 5% by weight. Decision paper 24590-HLW-TB-ENG-13-0001 requires operational restrictions to the transfer path between the HFP vessels and RLD except for vessel decommissioning.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify interface with the PWD to receive DIW for washing HFP vessel internals.	Documented in DVR.

3.5.3.12 Instrument Service Air Purge to GFR Supply Line

Requirement: The MFPVs shall interface with the safety instrument service air system (ISA) to receive a continuous air purge of the GFR supply line. [Sections 3.3.5.2.3, 4.3.23, 4.4.23, PDSA - HLW Facility](I.4).

Basis Discussion: The GFR supply line is continually purged with a low airflow from the safety ISA to prevent backflow of contamination from the MFPVs to the GFR during normal operation.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify interface with the MFPV to receive Safety ISA purge to the GFR supply line.	Documented in DVR.

3.5.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.5.4.1 Vessel Washing

Requirement: The HFP vessels shall be designed with internal spray mechanisms to perform vessel washing and removal of contamination. [Sections 11.7.4, 16.4.8, BOD][Section 14.2, 20.0, ORD] (D.2, H.1).

Basis Discussion: The internal spray mechanisms used to wash the HFP vessels help to facilitate the removal of contamination and prevent the buildup of solids on the vessel walls. The vessel washings are processed forward to the melters during normal operations. The HFP vessels are to be cleaned prior to removal for D&D or maintenance/replacement activities. The steam ejectors are only used to transfer vessel washwater to the RLD prior to vessel decommissioning.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an Analysis to verify the spray mechanisms are capable of washing the vessel walls and internals.	
R	ENG	Review of design to verify incorporation of internal spray mechanisms are designed in accordance with 24590-WTP-GPG-M-013, *Plant Wash System Design.*	

3.5.4.2 Operator Reaction Time

Requirement: The HFP system shall have the capability to automatically transition from normal processing to a safe state or idle mode during a casualty event without relying on operator manual action for at least 30 minutes after the onset of a credible failure event. [Section 11.10, ORD]

Basis Discussion: In the event that excess liquid accumulates in a vessel from a credible failure event (e.g. pump doesn't turn off or is inoperable, plugged piping, etc.) provisions are provided to properly contain the liquid without operator manual action for at least 30 minutes. The vessels are provided with high level limit switches which are interlocked with pumps and other equipment. If the high level is reached, equipment is operated to control the liquid level in the vessel. If these interlocks or equipment fail, overflow features are provided to route the liquid to sumps.
[ALARA]

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the HFP design to verify no manual operator action is required to contain contaminated liquid for 30 minutes after a credible failure event.	Document in an evaluation/assessment. Ops to participate in and/or review the evaluation/assessment.

3.5.4.3 Pneumercator Plugging Prevention

Requirement: Purge air liquid level instrumentation (pneumercator) in process vessels shall be designed to prevent plugging. There shall also be a mechanical (clean-out port) capability available for unplugging the pneumercator tubes if a plug occurs and flushing is unsuccessful. [Section 11.16, ORD]

Basis Discussion: The purge air liquid level instrumentation in process vessels design to prevent plugging is the primary means to prevent plugging; the mechanical clean-out ports are an alternative means of plugging clean-out.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the required pressure to prevent pneumercator plugging and identify the interfacing service air source.	
R	ENG	Review the HFP design to verify attributes exist to prevent plugging; including mechanical clean-out ports.	Design features such as automatic bubbler flushes would satisfy this requirement.

3.6 Piping Requirements

3.6.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.6.1.1 Piping Design

3.6.1.1.1 Fully Welded Piping

Requirement: All in-cell process piping that is nonmaintainable shall be fully welded. [Sections 11.7.4, 16.4.1.1, BOD].

Basis Discussion: The in-cell piping in contact with the HLW concentrate provides containment of the process fluid. Traps for contamination should be mitigated by fully welded pipe connections.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the system design to verify adoption of fully welded nonmaintainable piping.	Documented in DVR (although not safety, hard-to-reach piping is included).

3.6.1.1.2 Siphon Prevention

Requirement: [HOLD] The piping design shall provide one barometric head of isolation on service piping lines below the maximum liquid level of the associated vessels/tanks and piping features. The piping design for spargers, sample/transfer pump priming lines, ADS pump lines, cooling jacket lines, steam ejectors, and bubblers

shall meet this requirement. [Sections 3.3.5.2.8, 3.3.5.2.11, 3.3.5.6.4, 4.4.7, 4.4.23.3, 5.6.7, 5.6.14, 5.3.2.12, 5.6.34, PDSA - HLW Facility][Section 7.1, ORD].

Basis Discussion: One barometric head of isolation on service piping lines prevents contamination spread up these utility or process lines (accomplished by 34 ft of vertical pipe or piping to a destination open to air, and the piping/destination is always above the liquid level in the vessel). This requirement and HFP vessel sparge tube design are on "**[HOLD]**" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging. This hold only applies to sparging; other utilities described within the requirement are not on hold.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to verify that one barometric head of isolation is provided below the maximum liquid level for the spargers, sample/transfer pump priming lines, ADS pump lines, cooling jacket lines, steam ejectors, and bubblers.	
R	**ENG**	Review the design to verify the spargers, sample/transfer pump priming lines, ADS pump lines, cooling jacket lines, and bubblers meet this requirement.	Documented in DVR.

3.6.1.1.3 Double-Walled (Coaxial) Piping

Requirement: The HLW concentrate transfer piping from the PT Facility to the HLW Facility shall be an underground, double-walled (coaxial) pipeline. [Sections 4.4.4.2, 5.6.7, PDSA - HLW Facility][Section 5.6.20, PDSA - PT Facility][Section 14.10.1.3, BOD].

Basis Discussion: To provide a dual containment boundary for transferring the HLW concentrate between the PT Facility and HLW Facility. Radioactive liquid transfer lines are double-encased to minimize the potential for release of contamination due to the breach of a process line. Coaxial lines have the provision to pneumatically test both primary and secondary lines for leakage (Section 14.3, ORD). See Section 3.4.2 for allocation of leak detection requirements. The transfer lines are also buried to reduce worker radiation exposure due to high dose rates.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review the design to verify the piping from the PT Facility to the HLW Facility is double-walled.	Documented in DVR.

3.6.1.1.4 CoAxial Leak Testing

Requirement: The HFP/HCP Coaxial lines shall have the provision to pneumatically test both primary and secondary lines for leakage. Coaxial lines shall also have on-line primary containment leak detection capability. [Section 14.3, ORD]

Basis Discussion: The Coaxial piping (pipe within a pipe) contains test ports for the inner and outer pipes such that leakage testing may be performed to verify containment integrity.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify the HFP/HCP Coaxial piping includes provisions to pneumatically test both the primary and secondary lines for leakage and includes on-line leak detection capability.	Documented in DVR.

3.6.1.1.5 Coaxial Piping Support

Requirement: The underground HLW concentrate transfer piping from the PT Facility to the HLW Facility shall be designed such that it is supported and protected from physical damage resulting from backfill settlement, vibration, expansion or vehicular traffic. [Section 14.10.1, BOD]

Basis Discussion: Backfill materials supporting the transfer piping from PT to HLW should not allow stresses on the coaxial piping that could cause physical damage. Procedures described in American Petroleum Institute (API) Recommended Practice 1615, Installation of Underground Petroleum Storage Systems (API 1996a) or ANSI Standard B31.3, *Liquid Petroleum Transportation Piping Systems* (ANSI 1987) may be used as guidance.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify the piping from the PT Facility to the HLW Facility is supported and protected from physical damage.	May be documented in an evaluation or assessment.

3.6.1.2 Pressure Relief Valves

Requirement: Pressure relief valves shall be configured using a full port three-way valve, dual pressure safety valves (PSV), and drain valves on each leg. [Section 14.4, ORD]

Basis Discussion: Pressure relief valves are configured so that there is no service outage while servicing a PSV. Pressure relief valves are located on the HPS inlet to the heat exchangers, hot water outlet of the heat exchanger, hot/cold water return from the decontamination vessels, and at the hot water head vessels.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the piping design to verify pressure relief valves are configured using full port three-way valves, dual PSVs, and a drain valve on each leg.	Document in DVR

3.6.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.6.2.1 Mechanical Isolation of Utility Supply Lines

Requirement: The utility supply lines (i.e., air, steam, glass formers, plant wash, and cooling water) to the HFP vessels shall include provisions to mechanically isolate from all waste transfer lines that can potentially result in contaminating the utility supply lines. The steam supply line to the steam ejectors shall be provided with a welded fitted end fitting. The glass former feed line shall be provided with an isolation valve that interlocks closed upon indication of potential for loss of confinement. [Sections 3.4.1.7.1.5, 4.3.15, 4.3.15.1, 4.4.23, 4.4.23.1, 4.4.23.2, 5.6.14, 5.6.35, PDSA - HLW Facility][Section 7.1, 14.1, ORD][Section 5.1.2, BOD].

Basis Discussion: This mechanical isolation design feature (e.g., valves, blind flanges, spectacle blinds, or capped lines) ensures there is no connection between utility supply lines to prevent backflow of contamination. The steam ejectors and jumpers are not installed in the vessel during normal operations; therefore, no connection exists between the ejectors and the steam supply. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify mechanical isolation capabilities on utility supply lines to the HFP vessels.	Documented in DVR. The steam supply line will be verified to have a welded end fitting and the GFR feed line isolation will include an interlock to close on loss of confinement signal.

3.6.2.2 Transfer Lines Slope Between High Level Waste Facility and Pretreatment Facility

Requirement: The coaxial transfer piping from the PT Facility to the HLW Facility design shall be sloped toward the PT Facility. [Section 5.6.7, PDSA - HLW Facility] [Section 14.10.1.3, BOD] (A.1).

Basis Discussion: The Slope of the transfer piping towards PT is to promote self-draining. This is an ALARA feature because it allows for residual waste to transfer back to containment without being pumped back reducing the source term in the lines. For additional details on pipe sloping, refer to 24590-WTP-GPG-M-027, *Recommended Slopes for Piping Systems* and slope requirements in 24590-WTP-M6-50-00008, *P&ID Symbols and Legend Sheet 8 of 8.*

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify coaxial piping between the PT Facility and HLW Facility is designed to drain back to the PT Facility.	Documented in DVR.

3.6.2.3 Hydrogen Explosions

Requirement: The HFP piping/tubing shall maintain integrity during and after multiple internal hydrogen explosions by design and configuration. [Sections 4.4.27, 4.4.27.1, PDSA - HLW Facility][Appendix C.2.3.1, BOD].

Basis Discussion: The safety function of the piping/tubing in contact with waste (including safety air tubing as applicable) is to reduce the probability of a failure by providing confinement during and after multiple hydrogen explosions (Section 4.4.27.1, PDSA - HLW Facility). Hydrogen is generated within waste and water/reagents systems in piping and ancillary vessels of the HLW Facility by means of thermolysis and radiolysis. This hydrogen may build up in piping and ancillary vessels and exceed the LFL (refer to Section 4.4.27.2 of PDSA - HLW Facility). Criteria have been established for conditions where detonations in piping and in-line components due to hydrogen accumulation may be allowed. For normal operations the quantity of hydrogen must be less than that which (if detonated) would result in an explosion that stresses the pipe beyond the through-wall average elastic limit (will not fail in ductile fracture). This means the pipe confinement boundary will survive repeated explosions without repair or replacement (refer to Section 4.4.27.3 of PDSA - HLW Facility).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to document the HFP piping/tubing maintains integrity during and after multiple hydrogen explosion	Documented in DVR.
R	ENG	Review of design to verify conformance to the analysis results.	Documented in DVR.

3.6.2.4 Black Cell Seismic Evaluation

Requirement: The HLW-HCP and HFP piping located in black cells (e.g., coaxial transfer piping, concentrate receipt piping, etc.) shall be evaluated using approved seismic category SC-I methods and acceptance criteria as defined in the SRD. [Section 16.4.2.7, BOD]

Basis Discussion: The HCP and HFP piping is listed in Table B-1 of the BOD, Appendix B, and is therefore allowed to be designed for the WTP site-specific ground motion. The evaluation of black cell piping to the seismic category SC-1 design basis event (DBE) provides additional protection to seismic category SC-1 SSCs during seismic events.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify HLW-HCP and HFP Piping located in black cells are evaluated using approved SC-I methods and acceptance criteria as defined in the SRD.	

3.6.3 System Interface Requirements

3.6.3.1 PT Facility PWD, ASX, DIW - Pipe Flushing Interfaces

Requirement: The piping design shall interface with the following systems to provide flush of demineralized water (up to three line volumes) into the transfer pipe lines.[Section 6.2.1, BOD][Section 14.3, ORD](B.1, E.1, G.1).

- **HLW concentrate piping between the PT Facility and HLW Facility MFPV**
  - Flush water source: demineralized water system (DIW) via PWD

  - Flush velocity range: TBD fps for slurries without glass formers
- **HLW melter feed piping from MFPV to MFV**
  - Flush water source: DIW system via ASX
  - Flush velocity range: TBD fps for slurries with glass formers
- **HLW melter feed piping from MFV to melter**
  - Flush water source: DIW system via ASX
  - Flush velocity range: TBD fps for slurries with glass formers
- **HLW process waste transfer line between melter caves 1 and 2**
  - Flush water source: DIW system via ASX
  - Flush velocity range: TBD fps for slurries with glass formers (bounding)

Basis Discussion: The transfer lines are flushed to remove waste from the lines to prevent plugging and the accumulation of waste that could generate hydrogen (Sections 1.4, 4.5.1, *Minimum Flow Velocity for Slurry Lines*). A minimum flush velocity of 6 fps was determined in CCN 241253, *Response to Defense Nuclear Facilities Safety Board (DNFSB) Staff Issue Report Regarding Plugging of Process Lines, Pretreatment Facility, Waste Treatment Plant, Hanford Site* based on the test data.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the required flush paths to determine the minimum flow velocities.	
R	ENG	Review of design to verify conformance to the analysis results.	
T	SU/COM	Perform integrated system test to verify flushing velocity meets the acceptable range for the sample and transfer lines listed in the requirement above. Flushing demineralized water to not exceed three line volumes.	

3.6.3.2 PT Facility DIW – HFP Recirculation Flushing Interface

Requirement: The piping design shall interface with the HFP sample recirculation piping to provide flush of demineralized water (up to three line volumes) into the transfer pipe lines.[Section 6.2.1, BOD][Section 14.3, ORD](A.3.1, A.6.1, B.1, E.1).

Basis Discussion: A minimum flush velocity of 6 fps was determined in CCN 241253, *Response to Defense Nuclear Facilities Safety Board (DNFSB) Staff Issue Report Regarding Plugging of Process Lines, Pretreatment Facility, Waste Treatment Plant, Hanford Site* based on the test data.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the required flush paths to determine the minimum flow velocities.	

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the transfer and recirculation pipe lines to ensure the required flush velocity can be achieved.	
R	ENG	Review of design to verify conformance to the analysis results.	
T	SU/COM	Perform integrated system test to verify flushing velocity meets the acceptable range for the sample recirculation lines listed in the requirement above. Flushing demineralized water to not exceed three line volumes.	

3.6.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.6.4.1 Flushing, Draining, and Slopes

Requirement: The piping design shall provide the capability to be flushed and drained with no traps or pockets that can accumulate liquids or solids that are not drained. The piping shall allow a means to break vacuum to allow gravity liquid draining. [Sections 7.1, 14.3, 20.0, ORD][Sections 11.4.1, 16.4.2.7, BOD] (B.1, E.1, G.1).

Basis Discussion: The piping provisions for draining and/or pumping fluid prevents lines from plugging and minimizes contamination levels during equipment maintenance and/or replacement, in support of as low as reasonably achievable (ALARA) design objectives.

[ALARA]

For additional details on pipe sloping, refer to 24590-WTP-GPG-M-027 and 24590-WTP-M6-50-00008, *P&ID Symbols and Legend Sheet 8 of 8*. Level piping for a short distance through wall penetrations, at connections to equipment, and at jumpers is acceptable (Section 14.3, ORD). In-cell instrument air lines connected using flexible jumpers are not considered process piping and are not required to be sloped (Section 7.1, ORD).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design (i.e., piping and instrumentation diagrams [P&ID]) to verify flushing capabilities and that the piping is designed to break vacuum and gravity drain with no traps or pockets.	May be documented in an assessment/evaluation.
T	SU/COM	Demonstrate flushing and draining capabilities during integrated system testing.	This will be performed during the verification of requirement 3.6.3.1

3.6.4.2 Water Hammer

Requirement: HFP and HCP automatic valve closure rates shall be sufficiently slow to prevent damage from water hammer. [Section 14.4, ORD] [Section 11.7.4, BOD]

Basis Discussion: The HFP and HCP design considers water hammer in the design of automatic valve closure devices. The devices control the rate of valve closure to prevent damage to the piping systems from water hammer.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the performance criteria for slow closing valve actuators is adequate to prevent water hammer during valve closure.	
R	ENG	Review HFP and HCP design to verify slow closing valves have been incorporated into the design where required to prevent water hammer.	

3.6.4.3 Instrument Flush Mounting

Requirement: HCP and HFP Instrumentation installed in piping with solids shall be flush-mounted. [Section 11.16, ORD]

Basis Discussion: Flush mounting prevents solids from plugging and the instrumentation from providing erroneous indications as it does not create an obstruction of flow where solids could accumulate. For example, transducers installed in a short pipe stub would fill with solids.
[ALARA]

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify instrumentation installed in HCP/HFP process piping are flush mounted.	

3.7 Mechanical Agitator Requirements

3.7.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.7.1.1 Vessel Mixing

3.7.1.1.1 Normal Mixing

Requirement: The agitation design shall be capable of mixing the HFP vessel contents (HLW concentrate with glass formers) during normal operations at an acceptable degree of homogeneity. [Section 14.14, ORD][Section 2.2, 4.1.2.2, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] (A.2, A.5, A.9).

Basis Discussion: Acceptable homogeneity is defined within Vitreous State Laboratory testing final report, 24590-101-TSA-W000-0009-195-00003, as having a weight percent solids bias under 4%. Agitation of the wastes helps prevent the build-up of settled solids. Agitation of the HFP vessels is also required to collect a representative sample of vessel contents to ensure the final product will meet waste acceptance product

specifications requirements (24590-HLW-WSF-ENG-07-005, *WAI Screening of HFP Sample Loop Flow Meter*). All volumes of material are continually mechanically mixed to prevent settling of solids. Testing of the mechanical agitator has been successfully conducted and the agitator impeller design attributes are documented in Part B of 24590-HLW-WIQP-MS-09-0002, WAI Item Qualification Plan for HLW Melter Feed Preparation Vessel Agitators. 24590-101-TSA-W000-0004-172-00001, Technical Basis for HLW Vitrification Stream, clarifies the agitator should be capable of mixing concentrate with glass formers with a yield stress of ≥30 Pa and a viscosity of ≥40 cP.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to determine the rate of mixing required to provide a representative sample from the HFP vessels.	
R	**ENG**	Review mechanical agitator design to verify agitation provides a homogeneous mixture.	Document in the completed 24590-HLW-WIQP-MS-09-0002, WAI Item Qualification Plan for MFPV Mechanical Agitators
T	**ENG (R&T)**	Demonstrate the mechanical agitator operation using simulant with a yield stress and viscosity representative of HLW concentrate and glass formers.	Research and Technology (R&T) testing performed by the Vitreous State Laboratory can be found in Section 4.4.2 and Table 3.5 - High Bound, 24590-101-TSA-W000-0009-195-00003, *Pretreated Waste and Melter Feed Composition Variability Testing using HLW Simulants*

3.7.1.1.2 Start-up Torque

Requirement: The mechanical agitator startup torque shall be capable of overcoming a bounding design settled solids shear strength composed of HLW concentrate and glass formers. (A.2, A.5, A.9).

Basis Discussion: 24590-101-TSA-W000-0004-172-00001, Technical Basis for HLW Vitrification Stream, states the agitator should be capable of overcoming a settled solids shear strength of 625 Pa. The bounding shear strength value of 625 Pa was established based on a plant-upset condition where restart is attempted with a mechanical agitator immersed in a layer of settled solids.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to determine the bounding design settled solids shear strength.	
R	**ENG**	Review the design to verify the HFP vessel mechanical agitator is capable of overcoming a settled bounding design settled shear strength.	
T	**ENG (R&T)**	Demonstrate the mechanical agitator is capable of overcoming the settled solids shear strength of a simulant with maximum settled solids shear strength of ≥ 625 Pa	R&T testing performed by the Vitreous State Laboratory can be found in Section 4.4.7, Table 4.27, Figure 4.100, 24590-101-TSA-W000-0009-195-00003,

Verif. Method	Verif. By	Plan	Notes/Comments
		with other rheology parameters identified on the mechanical agitator datasheets.	*Pretreated Waste and Melter Feed Composition Variability Testing using HLW Simulants*

3.7.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.7.2.1 Design Basis Event - Impeller Impact

Requirement: The mechanical agitator shall be designed to not have sufficient rotational energy and mass to breach the HFP vessel walls. [Sections 4.4.16.2.1, 4.4.16.2.3, 5.6.2, PDSA - HLW Facility].

Basis Discussion: As a result of a hazard evaluation, the failure of the MFPV or MFV walls because of the impact of a mechanical agitator impeller was deemed not credible because the maximum impact energy from the mechanical agitator impeller with the MFPV or MFV does not impart sufficient energy to breach the vessel walls (Section 3.3.3.2, PDSA - HLW Facility). The inability to breach the vessel walls at the highest rotational speeds and without waste in the vessels is considered a passive design feature.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis documenting the impact of the mechanical agitator impeller against the HFP vessel walls will not result in a loss of containment/confinement.	Documented in DVR.
R	**ENG**	Review design to verify the mechanical agitator configuration and HFP vessel wall thickness design conforms to the analysis results.	Documented in DVR.

3.7.3 System Interface Requirements

None.

3.7.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.8 Air Sparger Requirements

3.8.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.8.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.8.2.1 Vessel Hydrogen Release

Requirement: [**HOLD**] The HFP vessels shall be capable of mixing the waste to release hydrogen and maintain vessel headspace hydrogen concentration level below the LFL. [Sections 4.3.8, 4.3.8.2, PDSA - HLW Facility](I.1, I.2).

Basis Discussion: This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the design is capable of mixing the waste to release hydrogen and maintain vessel contents below the LFL.	
R	ENG	Review of design to verify conformance to the analysis	Documented in DVR.

3.8.2.2 Sparger Wide-Mouth End

Requirement: [**HOLD**] The HFP vessel sparger design shall have a wide-mouth end. [Sections 4.3.8.2, 4.3.8.4, 5.6.5, PDSA - HLW Facility].

Basis Discussion: The spargers are designed with a wide-mouth end to reduce the likelihood of plugging. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the spargers have a wide-mouth end.	Documented in DVR.

3.8.3 System Interface Requirements

3.8.3.1 Instrument Service Air System- Normal Air Purge (Hydrogen Mitigation and Prevent Plugging)

Requirement: [**HOLD**] The HFP vessel spargers shall interface with the ISA system to provide a continuous idle air purge of at least 200 times the maximum calculated hydrogen generation rate (HGR) through the spargers. [Sections 3.3.5.2.3, 4.3.8.4, PDSA - HLW Facility] [Section 6.1, BOD](I.1, M.1.1).

Basis Discussion: NFPA 69-2002, Section 8.3.1, "Standard on Explosion Prevention Systems," states, "The combustible concentration shall be maintained at or below 25 percent of the LFL." A dilution rate of 200 times the HGR equates to approximately 0.5 vol % of hydrogen (where 1 vol % is a hydrogen concentration of approximately 25 % of the LFL). This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.
The normal air purge, through the spargers, provides a volumetric flow rate of at least 200 times the maximum calculated hydrogen generation rate (HGR), which maintains the maximum hydrogen concentration less than 0.5 % of the minimum headspace volume during normal operation. Calculation 24590-WTP-M4C-V11T-00011, *Revised Calculation of Hydrogen Generation Rates and Times to Lower Flammability Limit for WTP*, provides the HGR and time to LFL for the HFP vessels.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to verify the ISA provides air purge supply to the spargers of at least 200 times the maximum HGR.	Documented in DVR.
R	**ENG**	Review of design to verify the ISA will provide an idle air purge of at least 200 times the maximum HGR.	Documented in DVR
T	**SU/COM**	Perform integrated system test to verify the ISA provides air purge supply to the spargers of at least 200 times the maximum HGR.	Documented in DVR.

3.8.3.2 Instrument Service Air System - Design Basis Event (Air Sparging)

Requirement: [**HOLD**] The HFP vessel sparger design shall interface with the ISA system to provide emergency sparge mode (air sparging) at a minimum of 42 standard cubic feet per minute (scfm) for each sparger tube, which is supplied upon mechanical agitator failure or following a seismic DBE (or other loss of mechanical agitaton). [Sections 4.3.8, PDSA - HLW Facility](I.2, M.2.5).

Basis Discussion: Air sparging provides the capability to mix the vessel contents during and after a seismic DBE or other circumstance where the mechanical agitator is unavailable. Air sparging reduces the potential for a hydrogen explosion. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.. Air sparging ensures the waste stays mobilized reducing the build-up of solids and is therefore considered an ALARA feature.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify a minimum of 42 scfm for each sparge tube is supplied upon mechanical agitator failure or a seismic DBE.	
T	SU/COM	Perform integrated system test to verify ISA system provides emergency air sparging supply to the spargers at the minimum design flow rate 42 scfm/sparger tube.	Documented in DVR.

3.8.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.8.4.1 Sparger Flushing and Draining

Requirement: [**HOLD**] The HFP vessel spargers design shall be flushable and fully drainable. [Sections 4.3.8.2, 5.6.5, PDSA - HLW Facility][Section 11.4.1, BOD](D.1.2).

Basis Discussion: The DIW system provides flush water to the sparger lines into the HFP vessels to prevent plugging of the sparger lines. Each tube is equipped with a fitting to allow insertion of a mechanical cleaning device to facilitate unplugging, if needed. The flush water also provides the capability to dilute and overflow the vessel contents onto the melter cave floor during a seismic DBE, if needed, to reduce the potential for a hydrogen explosion. This dilutes and spreads out the vessel contents in such a way that hydrogen gas is not retained in the waste. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the system design to verify capability to flush and drain the spargers.	Documented in DVR.

3.9 Pump Requirements

3.9.1 Mission and Functional / Performance Requirements (Including States/Modes)

Refer to Sections 3.4.1.1.1 and 3.4.1.1.2.

3.9.1.1 Sample/Transfer Pumps

3.9.1.1.1 Backflushing Pumps

Requirement: The sample/transfer pumps shall have the capability to be backflushed. [Sections 14.3, 20.0, ORD][Sections 6.2.1, 6.3.3, 11.3.2 , BOD].

Basis Discussion: Backflushing the sample/transfer pumps will help to remove waste and prevent plugging (refer to Section 4.1.4 of 24590-HLW-TB-ENG-13-0002, *Engineering Design Decision for HLW HFP* and Section

4.10.5 of 24590-HLW-ES-ENG-13-003, *Risk Reduction Study for the High Level Waste (HLW) Facility: Failure Modes, Effects, and Criticality Analysis (FMECA), In-Service Inspection (ISI), and Plugging*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify sample/transfer pumps have the capability of being backflushed.	

3.9.1.2 Melter Feed (Air Displacement Slurry) Pumps

Requirement: The MFVs shall use ADS pumps for transferring melter feed to the melters. [Sections 11.7.4, 15.3.3, BOD](A.10).

Basis Discussion: The ADS pumps provide a pulsed transfer rate of HLW supply for glass production. The ADS pumps use air as the motive force to push slurry into the melter. The melter feed is transferred from the MFVs to the HLW melter feed nozzles by dedicated ADS pumps and feed lines to support melter design capacity.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify incorporation of ADS pumps from the MFVs to the melters.	Documented in DVR.

3.9.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.9.2.1 Sample/Transfer Pumps

None.

3.9.2.2 Melter Feed (Air Displacement Slurry) Pumps

3.9.2.2.1 Nuclear Safety Design

Requirement: The ADS pumps shall be designed with a minimum of schedule 80S equivalent housing and a 5/8 in. internal baffle plate to maintain confinement during multiple hydrogen explosions. ADS pumps shall be designed as pressure vessels. [Appendix C, SRD][Sections 4.4.27.1, 4.4.27.3, 4.4.27.4, 5.6.34, PDSA - HLW Facility].

Basis Discussion: The safety function of the ADS pumps is to reduce the probability of a release by providing confinement during a hydrogen explosion. Design per the indicated standards within the Code of Record to provide for a robust design.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the ADS pump design to verify the use of a minimum schedule 80S equivalent housing, a 5/8 in. internal baffle plate, and designed as pressure vessels.	Documented in DVR.

3.9.3 System Interface Requirements

3.9.3.1 Sample/Transfer Pumps

3.9.3.1.1 Demineralized Water - Pump Priming

Requirement: The sample/transfer pumps shall interface with the PWD system to receive water for priming. (D.1.1).

Basis Discussion: The MFPV sample/transfer pumps use demineralized water for priming to clear the pump and to initiate pumping without waste transfer until pump reaches operating capacity.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the pressure and flow required to provide motive force for the operating ADS pumps	
R	ENG	Review of design to verify the sample/transfer pumps interface with PWD to receive water for priming.	
T	SU/COM	Perform an integrated system demonstration to verify the demineralized water supply successfully primes the sample/transfer pumps.	

3.9.3.2 Melter Feed (Air Displacement Slurry) Pumps

3.9.3.2.1 Instrument Service Air - Air Supply

Requirement: The ADS pumps shall interface with the ISA system to receive air supply to provide the motive force for operating the ADS pumps. (A.10, I.3)

Basis Discussion: The ADS pump motive force is compressed air, which acts to push the slurry using a pulsed flow. The ADS pumps and self-clearing air flush is considered an ALARA feature.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify ISA system will provide motive force for operating ADS pumps.	

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/COM	Perform a test to verify the ISA provides adequate force to operate the ADS pumps at the required transfer rate.	This will be performed during the verification of requirement 3.4.1.1.2

3.9.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.10 Monitoring and Controls Requirements

3.10.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.10.1.1 Vessels

3.10.1.1.1 Temperature

Requirement: The HFP vessels shall include temperature-sensing capability and interface with the process control system (PCJ) to remotely monitor temperature of the waste. (M.1.1).

Basis Discussion: Temperature monitoring provides the capability to ensure processing conditions are maintained between the minimum and maximum operating temperature values.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the capability to remotely monitor the vessel temperature.	
T	SU/COM	Demonstrate the capability to verify remote monitoring of the HFP vessel temperature in the facility control room.	

3.10.1.1.2 Pressure

Requirement: The HFP vessels shall include pressure-sensing capability and interface with the PCJ system to remotely monitor pressure within the vessels. (M.1.1).

Basis Discussion: Pressure is monitored to provide processing feedback of the HLW melter feed conditions inside the HFP vessels. The system senses operating conditions and reports data to the PCJ.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the capability to remotely monitor the vessel pressure.	
T	SU/COM	Demonstrate the capability to verify remotely monitoring of the HFP vessel pressure in the facility control room.	

3.10.1.1.3 Level Detection

Requirement: The HFP vessels shall include level sensing monitoring with remote indication. The programmable protection system (PPJ) shall provide the level detection capabilities for safety control. [Sections 4.4.4, 4.4.4.1, 4.4.4.3, PDSA - HLW Facility] [Section 3.1, 4.1.1.2, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] [Section 14.10.1.1, BOD] [Section 14.4, ORD](M.1.1, M.2.9).

Basis Discussion: Level is monitored to ensure the batch transfer is successfully completed to the desired vessel level and does not exceed the maximum operating batch volume. Vessel level indication is WAI impacting due to its input to the glass former addition algorithm (section 6.7 of 24590-HLW-WSF-ENG-07-005). Level Detection is achieved with radar and bubbler type instrumentation. HFP Vessel level instruments (HFP-VSL-00001/00005/00002/00006) are Dangerous Waste Permit instruments as defined in Appendix 10.13 of the DWP. The batch level is also used by the glass formulation algorithm to determine the feed batch volume transferred to the MFV. The SS interlock is discussed in Section 3.10.2.1.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify the capability to remotely measure the HFP vessel content level using the PPJ for safety control.	See WAI item Qualification plan 24590-HLW-WIQP-J-10-0001

3.10.1.1.4 Level Accuracy

Requirement: The MFPV radar level instrument shall have an overall accuracy capable of providing the required input to the glass formulation algorithm, within the normal level operating range of the vessel, in accordance with the WAI requirement. The PPJ system shall provide the level detection capabilities for safety control. [Section 3.1, 4.1.1.2, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] (M.1.1, M.2.9).

Basis Discussion: The batch level is also used by the glass formulation algorithm to determine the feed batch volume that is transferred to the MFV. Because level instruments 24590-HLW-JL-HFP-LT-0051 and 24590-HLW-JL-HFP-LT-2051 provide information used to confirm the product meets the requirements of 24590-HLW-PL-RT-07-0001, *IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant*, they are given a WAI Performance SSC characteristic. The key WAI attribute for the level measurement instrument is an accuracy of ±2 % (refer to Section 6.7.2 of 24590-HLW-WSF-ENG-07-005, *WAI Screening of HLW Glass Chemistry Processing Activities*). In addition, the related SS interlock is discussed in Section 3.10.2.2.1.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the overall accuracy for the required input to the glass formulation algorithm.	See WAI item Qualification plan 24590-HLW-WIQP-J-10-0001 for level accuracy.

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design documents to verify overall full-scale instrument accuracy for the MFPV radar level instrument system aligns with the analysis provides the required input to the glass former algorithm.	24590-HLW-WSF-ENG-07-005 indicates the WAI instrument accuracy to be ±2 %.
R	ENG	Review the design to verify the PPJ system provides level detection capabilities for safety control.	
T	SU/COM	Perform integrated system test to verify the radar level instrument system has an overall full-scale accuracy that aligns with the analysis to provide the required input for the normal level operating range to the glass former algorithm.	24590-HLW-WSF-ENG-07-005 indicates the WAI instrument accuracy to be ±2 %.

3.10.1.2 Mechanical Agitators

3.10.1.2.1 Dual Speed Sensors

Requirement: [HOLD] The design shall include dual safety calibrated speed sensors to measure rotation speed of the mechanical agitator shaft. Speed sensors shall also be used for WAI. [Section 3.1, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] [Sections 4.3.8, 4.3.8.2, PDSA - HLW Facility](M.2.6).

Basis Discussion: The mechanical agitator speed sensors provide both WAI monitoring of the agitator rotational speed to ensure waste is being sufficiently mixed, and a safety function to detect agitator failure (which would necessitate a shift to emergency sparging). The rotational speed is WAI due to impacts on mixing and sampling (24590-HLW-WSF-ENG-07-005, *WAI Screening of HFP Sample Loop Flow Meter*). The PDSA states that agitator interlocks must be in alignment with "Reliability per IEEE 338, IEEE 379, and IEEE 384." This means both speed sensors must be classified as safety. This requirement and mechanical agitator speed sensor design are on "**[HOLD]**" due to differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging and downgrade the safety classification of the speed sensors.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the system design to verify the two safety mechanical agitator speed sensors are provided.	Documented in DVR.

3.10.1.2.2 Dual Motor Power Sensors

Requirement: [HOLD] The design shall include dual safety sensors to measure mechanical agitator motor power. [Sections 4.3.8, 4.3.8.2, PDSA - HLW Facility](M.2.7).

Basis Discussion: The mechanical agitator power sensors provide safety monitoring of the agitator motor power to detect a failure. The PDSA states that agitator interlocks must be in alignment with "Reliability per IEEE 338, IEEE 379, and IEEE 384." This means both power sensors must be classified as safety. This requirement and mechanical agitator speed sensor design are on "**[HOLD]**" due to differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging and downgrade the safety classification of the speed sensors.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the system design to verify two safety mechanical agitator power sensors are provided.	Documented in DVR.

3.10.1.2.3 Agitator Failure Detection

Requirement: Mechanical agitator motors speed and power status signals shall interface with the PPJ system for remote monitoring. [Sections 3.4.1.7.2.5, 4.3.8, 5.5.4.1, PDSA - HLW Facility](M.2.4, M.2.5, M.2.6).

Basis Discussion: The safety basis requires this to be an automated function controlled by the PPJ system.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify interface between the mechanical agitator speed and power sensor signals and the PPJ.	Documented in DVR.
T	SU/COM	Demonstrate the capability to remotely monitor agitator speed and power in the facility control room.	

3.10.1.3 Spargers

3.10.1.3.1 Flow Rate

Requirement: [**HOLD**] The HFP vessel sparger design shall include the capability to monitor the airflow rate supply to the spargers and interface with the PCJ system to remotely monitor the sparger flow rate. [Sections 4.3.8, 4.3.8.2, 5.5.4.2, PDSA - HLW Facility](M.1.1).

Basis Discussion: The flow sensors ensure HFP vessels spargers are operational and ensure the HLW Facility hydrogen mitigation system is functional. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging. arge tube airflow meets the SC single failure criteria.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify the capability exists to monitor flow through each sparger from the PCJ system.	Documented in DVR.
T	SU/COM	Demonstrate the capability to monitor the sparger airflow rates using the PCJ.	This will be performed during the verification of requirements 3.8.3.1 and 3.8.3.2.

3.10.1.3.2 Intermittent Emergency Sparge Mode

Requirement: [**HOLD**] The sparger valves shall interface with the PPJ system to receive a signal to initiate emergency sparge mode (air sparger) and to provide intermittent airflow to the spargers when the mechanical agitator is unavailable, after a seismic DBE, or due to agitator failure. Intermittent emergency sparging, of the HFP vessels, shall be performed sequentially such that no more than one vessel is being sparged at the same time and that the required airflow in each vessel is achieved. [Sections 4.3.8.2, 4.3.8.3.1, PDSA - HLW Facility](M.2.4, M.2.5).

Basis Discussion: The emergency sparge mode intervals are based on the waste characteristics and the time to LFL for the bounding HGR, as determined in 24590-WTP-M4C-V11T-00011, *Revised Calculation of Hydrogen Generation Rates and Times to Lower Flammability Limit for WTP*. Normal idle sparge mode still continues during the quiescent emergency sparge mode (air sparging) intervals. This requirement and HFP vessel sparge tube design are on "**[HOLD]**" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of the control system design to verify capability to provide intermittent air supply to the HFP vessels spargers.	Documented in DVR.
T	**SU/COM**	Demonstrate the capability to initiate emergency sparge air flow when the PPJ receives a signal following a seismic event or loss of agitator.	

3.10.1.3.3 Safety Air Control Valves

Requirement: [**HOLD**] The system design shall include ISA safety air control valves that control the HFP vessel spargers air supply and provide Safety purge ISA on a loss of the normal non-Safety purge ISA. [Sections 4.3.8, 4.3.8.3.1, 4.3.8.2, PDSA - HLW Facility](M.2.5, M.2.8).

Basis Discussion: ISA safety control valves ensure HFP vessels spargers are supplied with air from either the non-Safety ISA or Safety ISA systems. The safety air control valves are designed to maintain operations post seismic DBE by switching from the non-Safety ISA system to the Safety ISA system. The safety air control valves meet the single failure criteria. Check valves separate the HLW ISA normal air supply from the safety air supply. The check valves close if pressure is lost in the HLW ISA, preventing safety air from flowing out of a potentially failed ISA supply system. This ensures that safety air flows to the sparge tubes and does not backflow through unpressurized HLW ISA piping. This requirement and HFP vessel sparge tube design are on "**[HOLD]**" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the setpoint required to transition from the non-safety to safety purge ISA.	
R	ENG	Review design for ISA safety air control valves and verify the capability to change valve position by the PPJ when flow rate drops below the setpoint.	Documented in DVR.
T	SU/COM	Perform a test to verify the ISA safety air control valves switch from non-safety purge ISA to safety ISA supply to the spargers when the flow rate drops below the setpoint.	This will be performed during the verification of requirement 3.10.2.1.3

3.10.1.4 Pumps

3.10.1.4.1 Flow Rate to Autosampling System

Requirement: The MFPV sample line to the ASX shall include a calibrated flow meter to measure the sample stream flow rate. [Section 3.1, IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant] (M.1.1).

Basis Discussion: The ASX is required to collect a representative melter feed slurry sample from each batch in the HFP MFPVs. Flow rate measurement verifies the transfer rate is high enough to maintain a well-mixed sample at the ASX. If the collected samples are not representative, it could result in a false indication that the batch is qualified and be transferred into the MFVs for injection into the melter. 24590-WTP-J0-50-00012, *Controls & Instrumentation In-line Flow Devices Straight Run Requirements* and CCN 199857, *Modulating Control Valve Straight Run Guidelines* provides the guidelines for straight run requirements to ensure accurate flow measurement.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review sample line and pump design to verify that flow profile at flow meter meets meter requirements for accurate flow measurement per 24590-WTP-J0-50-00012, *Controls & Instrumentation In-line Flow Devices Straight Run Requirements* and CCN 199857, *Modulating Control Valve Straight Run Guidelines*	

3.10.1.4.2 Terminate Transfer to Melter

Requirement: **[HOLD]** The MFV ADS pumps shall interface with the PPJ system to receive an interlock shutdown signal to stop the pumps from transferring to the HLW melters when a high pressure setpoint is reached in the melter plenum. [Sections 3.3.5.1.8, 4.4.3.3.2, PDSA - HLW Facility](M.2.1, M.2.3).

Basis Discussion: Terminating transfer to the melters when a high pressure setpoint is reached in the melter plenum, which prevents overpressurizing the HLW melter. This requirement and HFP ADS pump design are on "**[HOLD]**" because due to a discrepancy between the PDSA and SDS table C-2. PIER 24590-WTP-PIER-MGT-14-0626 has been issued to resolve inconsistent wording within the PDSA. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design to verify capability to terminate transfer from MFV to the melter when a high pressure setpoint is reached in the melter.	Documented in DVR.
T	SU/COM	Demonstrate the capability to automatically terminate transfer from MFV to the melter, using the PPJ, when a high pressure setpoint is reached in the melter.	

3.10.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.10.2.1 Safety Class Interlocks

The system design shall include the following SC interlocks:

- Glass former feed line isolation valve (Section 4.3.15, PDSA - HLW Facility) Mechanical agitator failure (Section 4.3.8, PDSA - HLW Facility)
- Non-safety air purge low flow (Section 4.3.8, PDSA - HLW Facility)
- Seismic signal (Section 4.3.21, PDSA - HLW Facility)

3.10.2.1.1 Glass Former Feed Line Isolation Valve - Safety Class Interlock

Requirement: [**HOLD**] The glass former feed isolation valve shall interface with the PPJ system to receive a signal to close upon any of the following conditions: [Section 4.3.15, PDSA - HLW Facility](M.2.10).

- The MFPV mechanical agitator speed or power are outside of setpoint values
- Glass formers are not being fed to the MFPVs and the glass former isolation valve is open

Basis Discussion: This closure reduces the potential for contamination to migrate into the glass former feed system. The possibility of contamination migration decreases when the glass former isolation valve is closed. Therefore, the glass former isolation valve interlocks to close if glass formers are not being fed into the MFPVs, which is monitored by a rotary valve between the screw feed auger and the glass former feed isolation valve, or when the MFPV mechanical agitator speed or power are outside of setpoint values. This requirement and design associated with the GFR isolation to HFP are on "[**HOLD**]" because the operation of a single valve for an SC interlock does not meet single failure criteria. An additional redundant means to isolate this line is required to meet single failure criteria. Additional clarification needs to be included on the monitoring of glass formers being fed into the MFPVs. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the mechanical agitator speed and power setpoints required to isolate the glass former feed isolation valve.	
R	ENG	Review the control logic design to verify incorporation of the glass former feed line isolation valve interlock.	Documented in Safety System Requirement Specifications (SSRS)
T	SU/COM	Perform a test to verify the glass former feed line isolation valve closes in response to interlock signal.	

3.10.2.1.2 Mechanical Agitator Failure - Safety Class Interlock

Requirement: [**HOLD**] The HFP vessel sparger design shall interface with the PPJ system to receive a mechanical agitator failure SC interlock signal, when the agitator speed and motor power values are outside established setpoints, which shall automatically transition the air spargers from idle purge to emergency sparge mode. [Sections 4.3.8, 4.3.8.4 PDSA - HLW Facility](M.2.6, M.2.7).

Basis Discussion: The HFP spargers are relied upon to provide sufficient agitation to mix the waste in the event that the mechanical agitator is unavailable. If the mechanical agitator speed or power values are outside established setpoints, then the PPJ system automatically activates the emergency spargers in the HFP vessels. Emergency sparge mode reduces the potential for a hydrogen explosion in HFP vessels by mixing the waste upon failure of an agitator. The safety basis requires this to be an automated function controlled by the PPJ system. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to determine the mechanical agitator speed and power setpoints required to transition the air spargers to emergency sparge mode.	
R	**ENG**	Review the control logic design to verify interface between the mechanical agitator speed and power sensors and the PPJ system to control the hydrogen mitigation system modes of operation.	Document in SSRS
T	**SU/COM**	Test the PPJ system to verify the emergency sparger mode is initiated when the mechanical agitator is unavailable (i.e., speed or power outside setpoints).	

3.10.2.1.3 Purge Air Low Flow - Safety Class Interlock

Requirement: [**HOLD**] The system design shall interface with the PPJ system to receive a non-safety air purge low flow SC interlock signal, if the air purge flow rate is below the normal flow setpoint, which will automatically transition the safety air control valves from non-safety to safety air supply to the HFP vessel spargers. [Sections 4.3.8, 4.3.8.4 PDSA - HLW Facility] (M.2.5, M.2.8)

Basis Discussion: The safety basis requires this to be an automated function controlled by the PPJ system. This requirement and HFP vessel sparge tube design are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a

sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the low normal flow setpoint which transitions the safety air control valves to the safety air supply.	
R	ENG	Review the control logic design to verify interface between the mechanical agitator speed and power sensors and the PPJ to control the safety air control valves.	Document in SSRS
T	SU/COM	Perform a test the PPJ system to verify the ISA safety air control valves switch from non-safety purge ISA to safety ISA supply to the spargers when the flow rate drops below the setpoint.	

3.10.2.1.4 Seismic Signal - Safety Class Interlock

Requirement: [HOLD] The system design shall interface with the PPJ system to receive seismic signal SC interlock signal, which shall automatically activate the air amplifiers on each HFP vessel in response to a seismic event. [Sections 4.3.7.2.2, 4.3.21, PDSA - HLW Facility](M.2.11).

Basis Discussion: The seismic signal interlocks mitigate post-seismic event consequences by performing required actions to achieve a safer facility state. Administrative controls will direct assessing the seismic monitoring or other alternate means and determine whether the manual activation of the seismic signal is required. Following a determined seismic action level, and per emergency response procedures, the operator activates the seismic signal. The manual activation will prompt the PPJ automatic control system and other interlocks to complete the required activation and isolation actions. This requirement and design associated with seismic activation of the air amplifiers are on "[**HOLD**]" due to a note in PDSA Section 4.3.21 which states: "The design of the seismic switch feature is being evaluated. An update to this section will be provided after completion of a new hazards analysis." The hold will be removed once the PDSA is updated and associated DUIs are incorporated. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design to verify activation of the air amplifiers upon initiation of the seismic signal interlock.	Documented in DVR.
T	SU/COM	Demonstrate the HFP vessel air amplifiers are activated in response to a seismic signal interlock signal.	

3.10.2.2 Safety Significant Interlocks

The system design shall include the following SS interlocks:

- HFP-VSL-00001/HFP-VSL-00005 high-high liquid level feed diversion valve (Section 4.4.4, PDSA HLW Facility)
- Glass former feed line isolation interlocks and purge air (Section 4.4.23, PDSA HLW Facility)
- Terminate Transfer to Autosampling System (Section 4.4.19.1, PDSA HLW Facility)
- Autosampling System Valve Position to Isolate Flush Connection (Section 4.4.19.1, PDSA HLW Facility)

3.10.2.2.1 MFPV Feed Diversion Valve - High-High Liquid Level Safety Significant Interlock

Requirement: [**HOLD**] The MFPV feed diversion valve shall interface with the PPJ system to receive a high-high liquid level interlock signal, if the MFPV content levels exceed setpoint values, which shall close the valve to stop the waste transfer to the MFPV and shutdown the HLP transfer pumps. [Sections 4.4.4, 5.5.9, PDSA - HLW Facility][Section 14.10.1.1, BOD](M.2.1, M.2.9).

Basis Discussion: If MFPV content levels exceed setpoint values, the PPJ then closes the feed diversion valve to prevent the MFPVs from being overfilled with HLW concentrate. This requirement and design of the feed diversion interlock are on "[**HOLD**]" due to differences between the SDS and the PDSA - HLW Facility. The PDSA Section 4.4.4 currently states that the MFPV feed diversion valve interlock is designed to close the valve to prevent overfilling the MFPVs and divert the waste back to the PT Facility. The SDS specifies isolation of transfers into the HFP vessels which could alternatively be achieved by isolation of the ADS pumps and GFR system. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to determine the MFPV high-high level setpoints which initiate interlock signals to shutdown the HLP pumps.	
R	**ENG**	Review the control logic design to verify incorporation of the high-high liquid level feed diversion valve interlock.	Document in SSRS
T	**SU/COM**	Verify the high-high liquid level feed diversion valve interlock will shut the feed diversion valve and turn off the HLP transfer pumps when MFPV content levels exceed setpoint values.	

3.10.2.2.2 Glass Former Feed Line Isolation Interlocks - Safety Significant Interlock

Requirement: [**HOLD**] The glass former feed isolation valve shall interface with the PPJ system to receive a signal to close, if any of the following MFPV setpoint values are exceeded: [Sections 4.4.23, 4.4.23.3, PDSA - HLW Facility] (M.2.10).

- Headspace pressure high
- Waste level high
- HOP pressure low

Basis Discussion: This interlock reduces the probability of radiological exposure to a facility worker by closing the glass former feed isolation valve upon indication of potential for loss of confinement. This requirement and associated design of the GFR isolation to the HFP system are on "[**HOLD**]" until it is determined whether the GFR isolation valve must be designed as SC or SS. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the Headspace pressure, Waste level, and HOP pressure setpoints which initiate the glass former feed interlock.	
R	ENG	Review the control logic design to verify incorporation of the glass former feed line isolation valve interlock.	Document in SSRS
T	SU/COM	Test the glass former feed line isolation valves close in response to the interlock signal from the scenarios listed above.	

3.10.2.2.3 Terminate Transfer to Autosampling System

Requirement: The HFP vessel sample/transfer pumps shall stop when an interlock signal from the PPJ system is received when liquid level is detected in the autosampler enclosure containment boundary. [Sections 3.3.5.1.10, 4.4.19.1, 5.5.10, PDSA - HLW Facility] [Section 14.10.1.1, BOD] (M.2.2).

Basis Discussion: The system liquid level alarm detects a failure of the ASX feed or return line and trips the interlock, which is designed to stop the melter feed sample process operations to prevent flooding the autosampler enclosure. This requirement is based on ALARA considerations if ASX enclosure were to overflow and cause exposure to employees.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the high level setpoint required to initiate an interlock signal.	
R	ENG	Review the control logic design to verify ASX liquid level interlock with the HFP vessel sample/transfer pumps.	Documented in DVR.
T	SU/COM	Perform a test to verify the HFP vessel sample/transfer pumps shutoff upon receiving a signal from the control system in response to a high liquid-level setpoint interlock in the ASX sample enclosure.	

3.10.2.2.4 Autosampling System Valve Position to Isolate Flush Connection

Requirement: The HFP sample/transfer pumps shall not be allowed to operate or shall terminate operation whenever the ASX three-way valves are open to the sample line flush connection position. [Sections 3.3.5.1.14, 4.4.19.1, 5.5.7, PDSA - HLW Facility] [Section 14.10.1.1, BOD] (M.1.1, M.2.1, M.2.2).

Basis Discussion: Without this prevention, highly contaminated sample liquid from the MFPVs or PWD vessel could backflow into the flush supply line and subsequent C2 zones. The flush connection valve is closed when the pump is in operation during transfer or sampling (refer to drawing change notices 24590-HLW-M6N-ASX-00008, *General Instrumentation Revision to HLW ASX System P&ID (ASX-SMPLR-00029)*, and 24590-HLW-M6N-ASX-00010, *General Instrumentation Revision to HLW ASX System P&ID (ASX-SMPLR-00042)*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the control system design to verify interlock/permissive of ASX three-way valve position switches with the HFP vessel sample/transfer pumps.	Documented in DVR.
T	SU/COM	Perform a test to verify the HFP vessel sample/transfer pumps cannot start up when the ASX three-way valves are positioned open to the sample line flush connection.	
T	SU/COM	Perform a demonstration to verify the HFP vessel sample/transfer pumps shutdown when the ASX three-way valves are positioned open to the sample line flush connection while the HFP vessel sample/transfer pumps are in operation.	

3.10.2.3 Implementation of Active Safety Instrumented Functions

Requirement: The active safety instrumented functions for the HFP and HCP system shall be designed in accordance with the safety criterion 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of the SRD. [Safety Criterion, 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2, SRD] (M.2)

Basis: The SRD establishes the criterion and applicable standards for the safety design. The design processes including 24590-WTP-GPG-J-015, *Safety Instrumented System Implementation* and the electrical design criteria are used to ensure independence and design compliance with the mandated standards. The completed designs are documented in Safety Systems Requirements Specification and other design documents, which are required to be verified to ensure compliance with the standards.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify the Safety Systems Requirements Specifications and designs are in accordance with the criteria and standards in Safety Criteria 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II.	Documented in DVR.

3.10.2.5 Additional Safety Instrumentation: Single Failure Criteria / Safety Class Requirements

Requirement: The HFP and HCP system, SC safety instrumented functions shall be designed in accordance with safety criterion 4.3-2 and 4.3-5 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II. [Safety Criterion, 4.3-2 and 4.3-5, SRD] (M.2)

Basis: For safety instrumented functions to meet the single failure criterion, additional work related to fire zone separation and a detailed single failure analysis following the guidance in 24590-WTP-GPG-ENG-0159, *Single Failure Analysis Process for Mechanical, HVAC and Control Systems,* is required. The completed designs are documented in Safety Systems Requirements Specification and other design documents, which are required to be verified to ensure compliance with standards.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify the Safety Systems Requirements Specifications and designs are in accordance with the criterion and standards in safety criterion 4.3-2 and 4.3-5 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II.	Documented in DVR.

3.10.3 System Interface Requirements

3.10.3.1 Active Safety Instrumentation, Programmable Protection System

Requirement: The HFP and HCP Instruments with active safety functions are required to interface with the PPJ or be engineered as local safety instrumented functions. Signal interfaces shall use standard 4-20 mA or digital contacts. Appendix C provides a list of the HFP and HCP active safety instrumented functions and implementing components for the HSH system. [Section 7.1, BOD] (M.2)

Basis: Active safety instrumentation is implemented independently to the normal control system (PCJ/ MHJ) through the PPJ system or in local logic solvers. The PPJ is the main safety system logic solver used on WTP and includes logic programming to implement the active safety controls.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify required interface included in specifications and material requisitions (MRs) used to procure active safety instruments.	

3.10.3.2 Process Control System - Instruments

Requirement: Instruments connected to the PCJ system shall not perform any credited active safety function. Instruments connected to the PCJ may include and perform safety boundary or retention functions. HFP instruments shall use standard commercially available instrumentation and communication protocols to interconnect to the PCJ system. Fieldbus or Modbus communication may be used. [Section 9.4.1, BOD] (M.1).

Basis Discussion: The PCJ is used as the normal process control system. The PCJ allows remote operator control and monitoring of the HFP processes (e.g., provisions for process level, temperature, pressure, cooling, and mixing, along with the ability to control and monitor pumps, motors, and valves to operate the HFP systems). Alarms and warnings are provided to bring operator attention to, and allow rectification of abnormal process situations.

The instruments are part of the HFP. The system logic and control software is part of the HFP, but resides and is implemented by the PCJ. The software interfaces with software and hardware on other systems to collectively form an integrated control system for WTP.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify required specifications (related to PCJ interface) are included in MRs used to procure instruments.	May be documented in an assessment/evaluation.

3.10.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.10.4.1 Process Control System - Remote Control Operations

Requirement: The HFP design shall include the following capabilities that are remotely controlled or monitored by the PCJ system: [Sections 9.4.2, 11.4.1, 11.8.3.1, BOD][Section 14.4, ORD](M.1.1, M.1.2, M.2.1).

Melter Feed Preparation Vessels:

- The design shall have the capability to remotely monitor the vessel headspace pressure, liquid level, and contents temperature using the PCJ.

Melter Feed Vessels:

- The design shall have the capability to remotely monitor the vessel headspace pressure, liquid level, and contents temperature using the PCJ.

Mechanical Agitators (Motor and Impeller):

- The design shall have the capability to remotely start and terminate operation using the PCJ (interlocks are provided via the PPJ).
- The design shall have the capability to transmit the operating shaft rotation speed and motor power to the PCJ.

Pumps (Sample/Transfer and ADS):

- The design shall have the capability to remotely start and terminate operation using the PCJ (interlocks are provided via the PPJ).
- The design shall have the capability to transmit the sampling transfer rate to the PCJ.
- The design shall include remote automatic sampling capability.

Spargers [HOLD]:

- The design shall have the capability to remotely start and terminate operation using the PCJ (interlocks are provided via the PPJ).
- The design shall have the capability to transmit the sparger airflow rate to the PCJ.

Monitoring Instruments:

- The design shall have the capability to communicate with the PCJ.
- The design shall provide the capability to access instruments to calibrate in-place or remove to calibrate in the maintenance area.

Remote Operated Valves:

- The design shall have the capability to remotely open or close using the PCJ (interlocks are provided via the PPJ).
- The design shall have the capability to transmit the operating position to the PCJ.

Basis Discussion: Only the spargers are on "[**HOLD**]" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging. These features are ALARA because they allow remote monitoring and positioning. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of design to verify control room remote monitoring and control features.	May be documented in an assessment/evaluation.
T	**SU/COM**	Demonstrate the PCJ remote control operations for all the listed HFP equipment/components on both melter lines.	

3.10.4.2 Programmable Protection System - Remote Control Operations

Requirement: All PPJ monitoring and control functions shall be forwarded to the PCJ system for operator interface. [Section 7.3.7.4, 9.10, BOD](M.2.1, M.2.2, M.2.3, M.2.4, M.2.5, M.2.6, M.2.7, M.2.8, M.2.9, M.2.10, M.2.11).

Basis Discussion: The PPJ functions (i.e., interlocks) are covered elsewhere in the document. Design guide 24590-WTP-GPG-J-015, *Safety Instrumented System Implementation*, provides the implementing instructions for this requirement. Remote operations are considered ALARA features.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review of design to verify that all PPJ monitoring and control functions are forwarded to the PCJ.	Documented in logic diagrams and SSRS.
T	**SU/COM**	Demonstrate all PPJ monitoring and control functions are forwarded to the PCJ.	Recommended to be performed in conjunction with individual PPJ requirements.

3.10.4.3 Accessibility for Calibration, Testing, and Inspection

Requirement: The HFP system design shall provide the capability to access and perform remote (in cave) or direct (out cave) calibration, maintenance, periodic functional testing, and inspections of equipment and components during normal operation in areas that are ALARA. [Section 6.7, 8.1.2, 9.12, 11.3.2.2, 11.5.1, 12.6.3, BOD][Section 9.1, 11.16, ORD] [Section III.10.C.5.c.iii., Dangerous Waste Portion of RCRA Permit].

Basis Discussion: Instruments requiring hands on preventive maintenance activities such as calibrations, functional testing or replacement should be incorporated into the system design so that online maintenance may be performed. Temperature elements installed in thermowells should allow removal without interrupting the process. Instrumentation required on contaminated process is preferable to located on remotely maintainable jumpers.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review design to verify configuration facilitates replacement and removal, or remote/direct calibration and maintenance, of equipment in areas that are ALARA.	Document in an evaluation/assessment. Plant Engineering to participate in and / or review the evaluation/assessment.

3.10.4.4 Automatic Flushing Controls

Requirement: [**HOLD**] Automatic flushing controls shall be provided for MFPV to MFV transfer and post-sampling of the HFP system, and on termination of transfer from MFV to melter and shall interface with the controls for the DIW, PWD, and ASX systems. [Section 20.0, ORD] [Section 6.2.1, BOD] (E.1, 3.10.4.4).

Basis Discussion: Automatic flushing controls of the sample and transfer lines will help to remove waste and prevent plugging (refer to Section 4.1.4 of 24590-HLW-TB-ENG-13-0002, *Engineering Design Decision for HLW HFP* and Section 4.10.3 of 24590-HLW-ES-ENG-13-003, *Risk Reduction Study for the High Level Waste (HLW) Facility: Failure Modes, Effects, and Criticality Analysis (FMECA), In-Service Inspection (ISI), and Plugging*). This requirement and design of HCP/HCP automatic flushing controls are on "[**HOLD**]" because this change has not yet been documented in the safety basis or in the change control process. An automatic flush connection and interlocked valving for the MFV and MFPV transfer pumps will direct flushing after sample/transfer activities have been completed. The PDSA currently only directs interlocking of flush valving and sampling pumps such that flushing and sample/transfers of waste do not occur at the same time. Automatic flushing requirements in the PT to HLW transfer line will also be addressed in a later PDSA update. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review the control logic to verify automatic flushing controls and interfaces with the DIW, PWD and ASX systems	
T	**SU/COM**	Test automatic flushing operations post-transfer and post-sampling for each transfer/sample line.	

3.10.4.5 Closed Circuit Television

Requirement: The capability to perform regulatory inspections of cell/cave floors, piping, and tanks shall be designed and included in the layout. Non-accessible cells and caves shall be provided with CCTV inspection ports at strategic points. [Section 12.4, ORD].

Basis Discussion: Cameras are generally located above sumps and near vulnerable items of equipment which have an elevated need for monitoring.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify CCTV inspection ports are incorporated which allow inspection of cell/cave floors, piping, and tanks.	

3.11 Other Structures, Systems, and Components Requirements

3.11.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.11.1.1 Demisters

Requirement: Each HFP vessel shall include a demister designed with a minimum efficiency to support the operation of the HOP system. (J.1.1).

Basis Discussion: Demisters are located on top of the HFP vessels and connect vessel to the HOP/PVV vent line. The demisters prevent excessive moisture and aerosols from being carried into the HOP HEPA filters.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the demister minimum efficiency and droplet size.	
R	ENG	Review of design to verify conformance to the analysis results.	

3.11.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.11.2.1 Air Amplifiers

3.11.2.1.1 Maintain Negative Pressure

Requirement: Each HFP vessel shall include an air amplifier system designed to maintain negative pressure in the vessel headspace by discharging airflow into the melter cave, in response to seismic signal activation. [Sections 3.4.2.1.1.3, 4.3.7.2, 4.3.7.2.2, PDSA - HLW Facility] (M.2.11).

Basis Discussion: Each air amplifier system (includes instrumentation and controls, valves, air distribution piping, and air amplifier with flapper valve) is supplied by safety air and has a flapper valve that opens into the melter cave. The air amplifiers (air ejectors) are located on top of the HFP vessels and mitigate pressurization of the HFP vessels by discharging excess air into the C5 melter cave. The air amplifier creates a low pressure in the headspace, which draws air in the overflow line through the flapper valve and exhausts the headspace gasses into the melter cave. The air amplifiers remain off during normal operations and automatically turn on when activated by the seismic shutdown signal.[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify incorporation of an air amplifier system for each HFP vessel sized to maintain negative pressure in the vessel headspace.	Documented in DVR.
T	SU/COM	Demonstrate the air amplifier is activated by the seismic shutdown signal.	This will be performed during the verification of requirement 3.10.2.1.4

3.11.2.1.2 Operability

Requirement: The air amplifiers shall continuously operate upon activation under post-seismic conditions. The HFP vessel air amplifiers shall be designed to prevent its opening mechanism from fully sealing closed. [Section 4.3.7.2.2 PDSA - HLW Facility].

Basis Discussion: The air amplifier is to be designed to not fully close during normal operations to prevent accumulation of solids around the opening mechanism's sealing surfaces that could cause it to adhere closed to the vessel. This could result in the air amplifier failing to open under abnormal operations (loss of negative pressure).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of the design to verify the air amplifier opening mechanisms do not seal-closed when in the closed position.	Documented in DVR.

3.11.3 System Interface Requirements

3.11.3.1 Air Amplifiers

3.11.3.1.1 Instrument Service Air - Air Supply

Requirement: [HOLD] The air amplifiers shall interface with the safety ISA system to receive the required flow of air to maintain negative pressure in the HFP vessels relative to the C3 zones when the facility is in seismic shutdown response mode. [Sections 3.3.5.2.12, 4.3.7.2.2, 4.3.23.2, PDSA - HLW Facility](I.3).

Basis Discussion: Per sheets 6, 7, and 82 of *Air Sparging Line Sizing Calculation*, 24590-HLW-M6C-HFP-00013, the air amplifiers are designed to operate by receiving 50 scfm of air at 80 psig to maintain negative pressure in the HFP vessels. The air amplifiers require safety compressed air to maintain a negative pressure in the HFP vessels during emergency sparge mode following the activation of the seismic signal. The negative pressure in the HFP vessels prevents a flow of unfiltered air from the HFP vessel headspace through a potentially broken utility/instrument line and into the C2/C3 zones. This requirement and HFP vessel sparge tube design are on "**[HOLD]**" due to the differences between the SDS and the PDSA - HLW Facility and the resolution is expected to eliminate sparging. The PDSA references utilization of a sparge tube design to for hydrogen mitigation while the SDS offers multiple hydrogen mitigation options; not including air sparging.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the ISA provides sufficient flow to maintain negative pressure in the vessel under post seismic conditions.	Documented in DVR.
T	SU/COM	Demonstrate the air amplifiers maintain negative pressure in the HFP vessels, relative to the C3 zones, when the facility is in seismic shutdown response mode.	

3.11.3.2 Control Valves and Instruments

3.11.3.2.1 Instrument Service Air - Air Supply

Requirement: The HFP control valves and instruments shall interface with the ISA system to receive air supply to provide the motive force to open/operate control valves and instruments. (I.3).

Basis Discussion: Remote operation reduces personnel exposure.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify the HFP control valves and instruments interfaces with the ISA system.	

3.11.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.12 Relevant Codes and Standards

3.12.1 Codes of Record

Table 3–5 identifies relevant external codes and standards applicable to the HCP and HFP design.
Use of the *Engineering, Procurement, and Construction (EPC) Code of Record*, 24590-WTP-COR-MGT-15-00001 is typically invoked in the design process through the documents identified in Section 3.12.2.
Beyond inclusion here, no attempt is made in this documents for allocation to SSCs.

In some cases, the expected means of verification may be established on the basis of tests or other criteria required by the codes and standards. This does not necessarily include verification or testing more appropriately defined in the procurement of individual sub-systems or components, or verification or testing that is a routine activity defined by specifications and/or procedures used by construction and startup.

Table 3–5 HCP and HFP Applicable Codes and Standards

Implementing Codes and Standards: [24590-WTP-COR-MGT-15-00001, Rev 0, Engineering, Procurement, and Construction (EPC) Code of Record]
• Not applicable
• API STD-620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks.*
• AWS D1.1, *Structural Welding Code - Steel.*
• AWS D1.6, *Structural Welding Code - Stainless Steel.*
• WAC 173-303, *Washington Administrative Code - Dangerous Waste Regulations.*
• ANSI/ANS 58.8-1994, *Time Response Design Criteria for Safety-Related Operator Actions.*[2]
• ANSI/ANS 58.9-1981, *Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems.* [2]
• ANSI/ISA-67.04.01-2006, *Setpoints for Nuclear Safety-Related Instrumentation*, as tailored in Appendix C of the SRD. [2]
• ASME B31.3-1996, *Process Piping*, as tailored in Appendix C of the SRD.[12]
• ASME SEC VIII, *Boiler and Pressure Vessel Codes, Rules for Construction of Pressure Vessels.* [12]
• IEEE 323-83, Qualifying Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix C of the SRD.[12]
• IEEE 338-1987, *Standard Criteria for Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*, as tailored in Appendix C of the SRD.[12]
• IEEE 344-1987 (R1993), IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix C of the SRD. [12]
• IEEE 379-1994, Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems, as tailored in Appendix C of the SRD. [12]
• IEEE 384-1992, *Standard Criteria for Independence of Class 1E Equipment and Circuits*, as tailored in Appendix C of the SRD.[12]
• IEEE 497-2002, *Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations* as tailored in Appendix C of the SRD. [2]
• IEEE 1023-88, *Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations.* [12]
• ISA-S84.01-1996, *Application of Safety Instrumented Systems for the Process Industries.* [12]
• NFPA 70-1999, *National Electrical Code*[2]
• NFPA 69-2002, *Standard on Explosion Prevention Systems*, as tailored in Appendix C. [2]
• NFPA 801-2003, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, as tailored in Appendix C of the SRD. [2]
• ANSI N42.18-1980 (R1991), *Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents.* [1]
• ASTM A 312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.*[1]
• ASTM A 240, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.* [1]
The HLW-PDSA specifies that design of selected portions of the HCP/HFP system per this code or standard is a credited design feature to help ensure the robustness of the design in support of the nuclear safety hazards analysis and selection of controls. [2] This code or standard from the SRD applies to components of the HCP/HFP systems that have a safety function.

3.12.2 WTP Design Criteria, Design Guides, and General Specifications

Table 3–6 identifies relevant discipline design criteria, guides, and general specifications applicable to the HCP and HFP systems. Use of these documents to develop the detailed design of SSCs is governed by engineering procedures. The majority of requirements contained within this document are derived from external codes and standards, or are specified methods and approaches to achieve standardization and consistency of design. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from these documents for tracing and verification, or to define how direction provided by these documents is applicable and allocated (or not) to individual SSCs.

Table 3–6 WTP Design Criteria, Design Guides, and General Specifications Applicable to HCP and HFP

Document Number	Title
Design Criteria Documents:	
24590-WTP-DC-M-06-001	Mechanical Systems Design Criteria
24590-WTP-DC-E-01-001	Electrical Design Criteria
24590-WTP-DC-E-06-002	Design Criteria for Independence of Safety Equipment and Circuits
24590-WTP-DC-E-07-001	Design Criteria for Electrical Jumpers
24590-WTP-DC-ENG-06-001	Design Criteria for Environmental and Natural Phenomena Hazard Qualification of Structures Systems and Components
24590-WTP-DC-PS-01-001	Pipe Stress Design Criteria Including "Pipe Stress Criteria" and "Span Method Criteria"
24590-WTP-DC-PS-01-002	Pipe Support Design Criteria
24590-WTP-DC-PS-03-001	Jumper Stress Design Criteria
24590-WTP-DC-ST-04-001	Seismic Analysis and Design Criteria
Design Guides:	
24590-WTP-GPG-ENG-004	Design Guide Pipe Stress, Pipe Layout, and Support Spacing
24590-WTP-GPG-ENG-005	Engineering Design Guide for Pipe Support
24590-WTP-GPG-ENG-086	Equipment Environmental Qualification
24590-WTP-GPG-ENG-0094	Pipe Design Work Process
24590-WTP-GPG-ENG-0099	Design Verification of Plant Design Deliverables
24590-WTP-GPG-ENG-0103	Equipment Seismic Qualification
24590-WTP-GPG-ENG-0109	Accessibility Review of Equipment and Components
24590-WTP-GPG-ENG-0118	Piping Component Stock Codes
24590-WTP-GPG-ENG-0119	Isometric Drawings Production
24590-WTP-GPG-ENG-0123	Disposition of Hard to Reach Spools
24590-WTP-GPG-ENG-0127	Processing Engineering Calculations
24590-WTP-GPG-ENG-0129	Waste Acceptance Impacting Determination
24590-WTP-GPG-ENG-0130	Waste Acceptance Impacting Item Qualification Plan
24590-WTP-GPG-ENG-0140	Hot Pipe Penetrations Through Concrete
24590-WTP-GPG-ENG-0141	WTP Radiation Damage Thresholds for Non-Metallic Materials

Table 3–6 WTP Design Criteria, Design Guides, and General Specifications Applicable to HCP and HFP

Document Number	Title
24590-WTP-GPG-ENG-0144	Piping Interface with Flexible Equipment-Stress Analysis Design Guide
24590-WTP-GPG-ENG-0145	SC-IIIE Piping - Stress Analysis Design Guide
24590-WTP-GPG-ENG-0146	Piping Coating System Selection Guide
24590-WTP-GPG-ENG-0149	Piping Classification Guide
24590-WTP-GPG-ENG-0150	Plant Design/Mechanical Systems Equipment Interfaces: Terminal End Equipment
24590-WTP-GPG-ENG-0153	Safety Instrumentation - Independent Protection Layer Identification
24590-WTP-GPG-ENG-0159	Single Failure Analysis Process for Mechanical, HVAC, and Control Systems
24590-WTP-GPG-ENG-0165	Pipe Stress and Supports Confirmation
24590-WTP-GPG-J-005	Control Systems Interfaces
24590-WTP-GPG-J-014	Control Systems Design Process Guide
24590-WTP-GPG-J-015	Safety Instrumented System Implementation
24590-WTP-GPG-J-016	Control Valve Sizing
24590-WTP-GPG-J-017	WTP Seismic Category Application to C&I Systems
24590-WTP-GPG-J-0057	Setpoint Calculations
24590-WTP-GPG-M-002	Hydraulic Seals
24590-WTP-GPG-M-005	Ejectors (Jet Pumps) for Liquid Slurry Pumping
24590-WTP-GPG-M-009	Jet Pumps (Ejectors) for Vacuum Generation
24590-WTP-GPG-M-011	Pipe Sizing for Compressible Flow
24590-WTP-GPG-M-012	Pump Net Positive Suction Head
24590-WTP-GPG-M-013	Plant Wash System Design
24590-WTP-GPG-M-016	Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model
24590-WTP-GPG-M-017	Design Parameters & Test Pressures for Equipment & Piping
24590-WTP-GPG-M-019	Vessel Sizing
24590-WTP-GPG-M-022	Liquid and Vapor Line Sizing By Formula
24590-WTP-GPG-M-023	Other Losses in Piping Systems
24590-WTP-GPG-M-027	Recommended Slopes for Piping Systems
24590-WTP-GPG-M-028	Vent, Drain, and Root Valve Sizing and Selection for Piping Systems
24590-WTP-GPG-M-032	Vessel Overflow and Gravity Line Sizing
24590-WTP-GPG-M-036	Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts
24590-WTP-GPG-M-047	Preparation of Corrosion Evaluations
24590-WTP-GPG-M-050	Pressure Vessel and Heat Exchanger Design
24590-WTP-GPG-M-052	Specifying Design Cycles for Equipment and Piping
24590-WTP-GPG-M-0058	Minimum Flow Velocity for Slurry Lines

Table 3–6 WTP Design Criteria, Design Guides, and General Specifications Applicable to HCP and HFP

Document Number	Title
24590-WTP-GPG-M-0059	Avoiding Chemical Line Plugging - Plant Design Considerations
24590-WTP-GPG-M-0061	Vessel Structural Analysis and ASME Section VIII Evaluation
24590-WTP-GPG-P-0003	Jumper Design Guide
24590-WTP-GPG-PL-002	Plant Design Material Control Guide
24590-WTP-GPG-SRAD-001	Design Guide for ALARA
Specifications:	
24590-HLW-3PS-HFP-T0003	Engineering Specification for HLW Melter Feed System Demisters, Air Ejectors and Overflow Flapper Valves
24590-WTP-3PS-G000-T0002	Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication
24590-WTP-3PS-G000-T0015	Engineering Specification for Environmental Qualification of Mechanical Equipment
24590-WTP-3PS-JQ00-T0004	Engineering Specification for Management of Supplier Software
24590-WTP-3PS-JQ00-T0005	Engineering Specification for Management of Supplier Safety Software
24590-WTP-3PS-JQ06-T0005	Engineering Specification for Environmental Qualification of Control and Electrical Systems and Components
24590-WTP-3PS-JQ07-T0001	Engineering Specification for Instrumentation for Package Systems
24590-WTP-3PS-JQ08-T0001	Engineering Specification for Construction and Installation of Controls and Instrumentation
24590-WTP-3PS-M000-T0001	Engineering Specification for Air Displacement Slurry Pumps
24590-WTP-3PS-MACS-T0003	Engineering Specification for Mechanical Agitators
24590-WTP-3PS-MPC0-T0009	Engineering Specification for Vessel-Mounted Vertical Transfer Pumps - WTP HLW Facility
24590-WTP-3PS-MV00-T0001	Engineering Specification for Pressure Vessel Design and Fabrication
24590-WTP-3PS-MV00-T0002	Engineering Specification for Seismic Qualification Criteria for Pressure Vessels
24590-WTP-3PS-MV00-T0003	Engineering Specification for Pressure Vessel Fatigue Analysis
24590-WTP-3PS-NWP0-T0001	Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping
24590-WTP-3PS-PB01-T0001	Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges
24590-WTP-3PS-PH01-T0001	Engineering Specification for Technical Supply Conditions 'QL' Pipe Supports
24590-WTP-3PS-PS02-T0001	Engineering Specification for Shop Fabrication of Piping
24590-WTP-3PS-SS00-T0001	Engineering Specification for Welding of Structural Carbon Steel
24590-WTP-3PS-SS00-T0002	Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel.

4 System Description

This section summarizes design output information, describing the current design and the operational and maintenance aspects of the system. The information provided below does not contain design requirements and should not be used as design input. The description of the current design contained in this section may not fully align with design requirements. This is acceptable within the context of this document. Areas of misalignment are to be resolved through appropriate mechanisms and the SDD updated to reflect changes made to the design. Changes to the descriptive text will be made following the changes to the lower tiered Engineering documents.

4.1 Configuration Information

4.1.1 Description of System, Subsystems, and Major Components

4.1.1.1 Overview

- *Process Flow Diagram HLW Receipt & Feed Preparation - 24590-HLW-M5-V17T-00001*
- *P&ID - HLW - HLW Melter Feed Process System - 24590-HLW-M6-HFP-00001001, -00001002, -00001003, and -00001004*
- *P&ID – HLW- HLW Melter Feed Process System -- 24590-HLW-M6-HFP-00002001, -00001002, and -00001003*

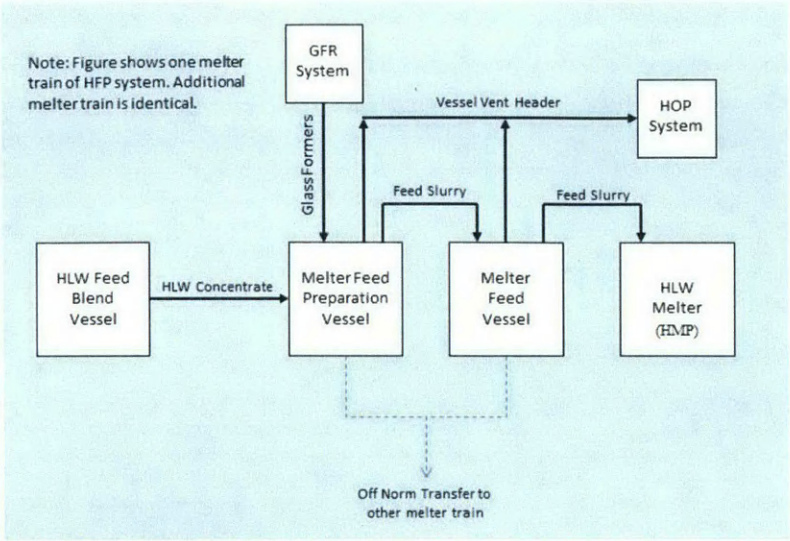
The HLW Concentrate Receipt Process system (HCP) receives HLW concentrate through waste transfer lines from the Pretreatment HLW Feed Blend Vessel (HLP-VSL-00028), part of the HLW Lag Storage and Blending Process System (HLP), and directs the waste stream to the Melter Feed Preparation Vessels (MFPV) of the Melter Feed Process System (HFP). The HFP system is designed to receive, blend, sample, and transfer the waste slurry to the melter. In the MFPVs, the HLW concentrate consists of solids from ultrafiltration, strontium/transuranic (TRU) precipitate, cesium concentrate and Cs/Sr[1] capsule (future waste). The HLW concentrate and glass formers are combined to make the HLW melter feed slurry. The glass former addition is calculated using a complex algorithm that uses data from the MFPV samples for the calculation. The blended melter feed is batch-transferred from the MFPVs to the Melter Feed Vessels (MFVs), where it is continuously transferred to the HLW melters. The system design incorporates two vessels (MFPV and MFV) so the waste mixture can be simultaneously prepared in the MFPV and constantly fed to the melter in the MFV.

The HFP system consists of two melter trains, with each train serving a dedicated melter. The HLW Melter 1 is supported by MFPV (HFP-VSL-00001) and MFV (HFP-VSL-00002) as shown on Process Flow Diagram 24590-HLW-M5-V17T-00001. The HLW Melter 2 is supported by MFPV (HFP-VSL-00005) and MFV (HFP-VSL-00006) as shown on Process Flow Diagram 24590-HLW-M5-V17T-00001.

A simplified flow diagram for the HCP and HFP systems is shown in Figure 4-1.

[1] Cs/Sr waste may be added to the waste feed in the HLP of the PT Facility. A future facility for processing of the Cs/Sr capsules will need to be completed before this waste can be added to the HLW feed.

Figure 4–1 Simplified Flow Diagram for HCP and HFP System



4.1.1.1.1 HLW Melter Feed Preparation

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001,*
- *Process Information for HFP Vessels - 24590-HLW-MVC-HFP-00001*
- *DRAWING - HLW Melter 1/2 Feed Preparation Vessel Assembly Drawing - 24590-QL-POA-MVA0-00018-03-00002*
- *P&ID - HLW - HLW Melter Feed Process System Instrumentation / VENT HFP-VSL-00001 - 24590-HLW-M6-HFP-00001003*

The MFPVs (HFP-VSL-00001/00005) mix HLW concentrate with glass formers from the HLW glass former mixers (GFR-TK-00025/00031).

Each MFPV is sized based for a maximum batch volume of 5500 gallons [**3.5.1.1.1**]. Each vessel is to support one melter and is capable of supporting melter feed at the required facility production rate with one melter operating at 3.75 MTG per day [**3.4.1.1.1**]. The batch cycle time for feed preparation is 25 to 54 hours varying with waste oxide loading, HLW solids concentration and glass yield. The MFPV normally receives feed from the upstream HLW feed blend vessel (or its designated back-up vessel).

The HLW concentrates from the PT Facility are transferred to the MFPVs through four separate lines. Of the four transfer lines, two are dedicated for each melter. The waste transfer lines are designed to permit valve lineups capable of directing flow to the MFPV or the PT Facility (PWD-VSL-00043). During normal operations, waste transfer is directed to the MFPV followed by a single line volume flush into MFPV. Subsequently, the valve positioning is changed such that line flushes from PT are directed back to the PT Facility (PWD-VSL-00043) via the return transfer line; minimizing waste dilution in the MFPV. The primary transfer line is normally used to transfer into the MFPV; while the secondary line directs flushes back to the PT Facility (PWD-VSL-00043). In the event the primary transfer line is taken offline, the secondary line will be used with a flush connection

attached in the melter cell. After each waste transfer is complete, the line is flushed by the PT HLP with plant wash fluid to prevent plugging of the transfer line. The plant wash fluid used to flush the lines is normally Demineralized Water or process condensate provided by the plant wash racks in the PT Facility; connections on the plant wash racks allow reagents to be used to aid in cleaning the pipe [**3.6.3.1**].

After transfer of waste concentrate from the PT facility to the HFP MFPV is complete, the batch is sampled to determine the glass former additives needed to create a waste compliant mixture for glass production. The glass former algorithm directs addition of glass formers to the MFPV by gravity transfer from the GFR mixer [**3.5.3.2**]. The mechanical agitator blends the glass formers and waste to a degree of homogeneity. Adequate mixing is based on administratively controlled mixing time and agitator speed control to help prevent build-up of settled solids thereby preventing inaccurate sampling results [**3.7.1.1.1**]. The agitator has the ability to resuspend solids in the event of a loss of agitation. To assist the agitators, baffles are located internal to the vessel. For further details on the baffles, refer to section [**4.1.1.2.5**]. When adequate mixing is achieved, the waste batch is again sampled and analyzed. Final sampling is a process hold point requiring satisfactory results before the waste batch may be processed forward from the MFPV to MFV.

The air sparging system in the HFP vessels provides hydrogen mitigation capability. The design of the HFP system includes sparge tubes for hydrogen mitigation and functions as a redundant method to prevent a Design Basis Gas Release Event (DBGRE). Hydrogen mitigation is achieved with agitator operation and idle sparger purge airflow forcing gases, including hydrogen, out of the waste and into the vessel headspace to be removed via ventilation. Section [**4.1.1.2.6**] contains further details on the air sparging system.

The MFPV headspace is vented to the Process Vessel Vent Exhaust (PVV) system. The PVV system is capable of maintaining a negative headspace despite air leakage into the vessels from various sources. Vented air from the vessel headspace must first travel through a demister to reduce particulate and aerosols. Following passage through the demister, the remaining air vents to the PVV system.

If melter feed in the MFPV is determined unsatisfactory for progression to the MFV due to sampling results, the batch is adjusted with the glass formers to allow processing. If the required addition of glass formers exceeds the volume of the MFPV, then transfer between the melter trains is allowed [**3.4.4.2**]. Out of spec batches are not permitted for transfer to the RLD system since the steam ejectors are only permitted for transfer of HLW concentrate from the HFP system to RLD during vessel decommissioning [**3.5.3.8**]. In lieu of using the steam ejectors to send vessel contents to RLD, a feed-forward operation strategy will be used to send all vessel contents to the melters.

The MFPVs are equipped with the following:

- Mechanical agitator [**3.7.1.2.1**]
- Air spargers for forced air purging of vessel head space and secondary agitation mechanism (on hold pending changes from SDS) [**3.10.1.3.2**]
- Air amplifier for Safety ventilation of the HFP head space [**3.11.2.1.1, 3.11.2.1.2**]
- Two mechanical pumps to transfer waste to the HLW MFV and the auto sampler [**3.4.1.1.3**]
- Demister on the vessel vent line for de-entrainment [**3.11.1.1**]
- Instrumentation for level, density and pressure measurement [**3.10.1.1.2, 3.10.1.1.3**]
- Thermocouple for temperature measurement [**3.10.1.1.1**]
- Cooling jacket to remove radioactive decay heat and heat generated by the agitator [**3.5.1.1.2**]
- Internal fixed nozzles for periodic wash-down [**3.5.4.1**]

- Steam ejector for transfer to the PWD vessel (RLD-VSL-00008) [**3.5.3.8**]
- Overflow path, equipped with flapper valve to prevent air in-leakage [**3.5.2.1.1, 3.5.2.1.2**]
- Internal baffles [**3.5.2.2**]

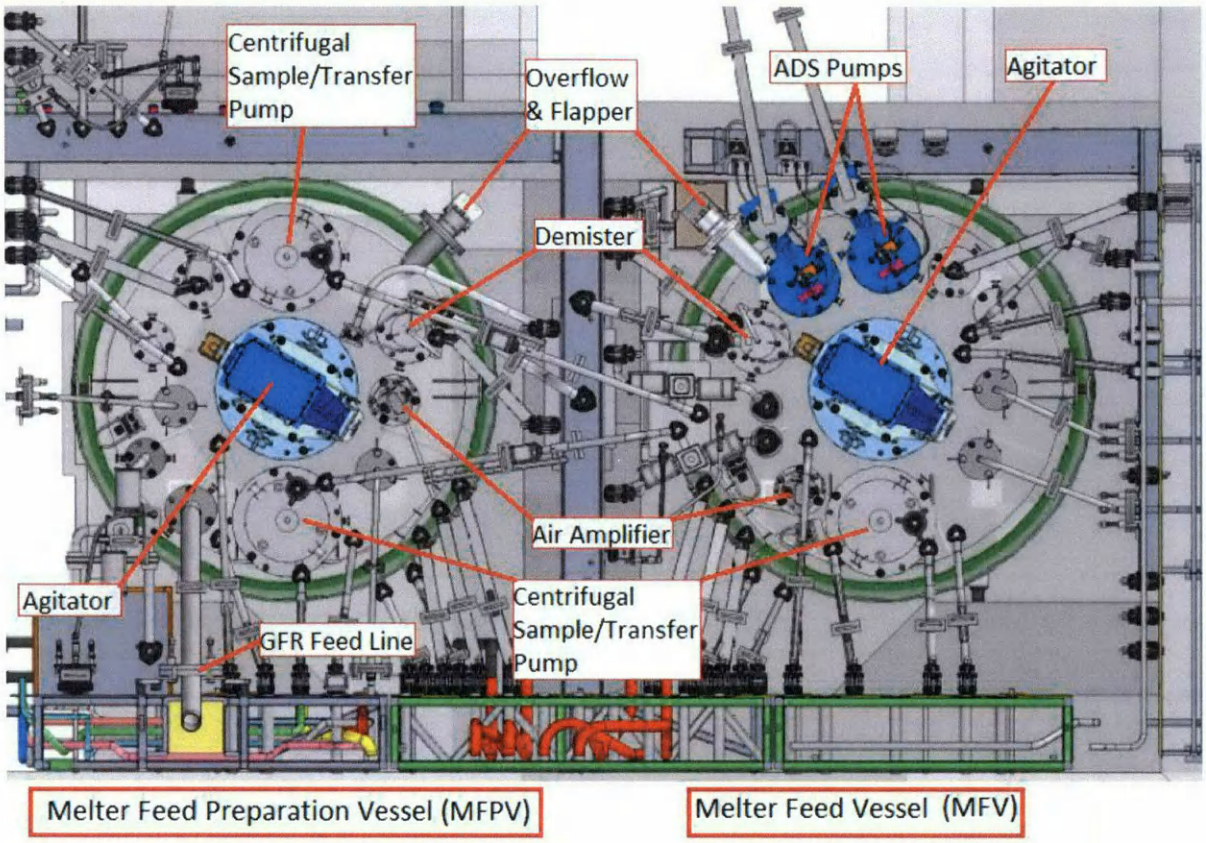
The MFPVs are equipped with two forms of level detection; radar as well as 'bubbler' style (differential pressure) density compensated level detection. The vessel level measurement in the MFPVs is interlocked to shut the glass former feed isolation, stop additional incoming waste from PT to the MFPV and alarm when high-high level in the vessel is detected. Samples are taken from the MFPV via the ASX sample cabinets and are analyzed by the Analytical Laboratory. To ensure a representative sample, flow detection is included on the sample line to verify transfer rate is adequate. High average velocity ensures a turbulent fluid stream and characteristic sample properties. The level and sample data are used in the glass former algorithm to determine the MFPV heel volume used and also determines the feed batch volume that is transferred from the MFPV to the MFV. Vessel levels before glass former addition are also used to predict the radionuclide content of the HLW glass within the IHLW canisters. Since the level instrumentation provides information used by the glass former algorithm to confirm the slurry meets the Waste Compliance Plan requirements, it is given a WAI Performance SSC characteristic. The key WAI attribute for the level measurement instrument is an accuracy of +/- 2 percent [**3.5.3.9, 3.10.1.1.3**]. Safety Classifications of equipment are identified by [**3.4.2.1**].

Each MFPV is equipped with two cantilever pumps for transfer through the ASX recirculation loop or to the corresponding MFV. Jumpers are available to allow transfer of feed to the redundant melter train. [**3.4.4.2**]

The HLW MFPVs are located in the melter cave. Removal and replacement of the vessel and its components is conducted remotely by the HLW Melter Cave Support Handling (HSH) System [**3.4.4.1**]. Due to the abrasive and corrosive nature of the feed slurry, the agitator and pumps will need to be replaced within the lifetime of the plant [**3.4.1.2.1**].

Figure 4-2 depicts the major subcomponents within the MFPV and MFV.

Figure 4–2 Overhead View of MFPV and MFV



4.1.1.1.2 HLW Glass Former Feed

- *HLW Melter Feed and Feed Preparation Vessel Utilization and Time CYCLE Evaluation - 24590-HLW-ES-PR-04-001*

The GFR mixers feed the glass formers determined by the glass former algorithm to the MFPV. The glass formers are mixed thoroughly with demineralized water (DIW) in the GFR mixers for dust mitigation purposes. The target water addition is approximately 5 % of the glass formers batch weight. The GFR system controls the discharge rate of wetted glass formers into the feed chute to the MFPV [**3.5.3.2**]. The boundary of the HFP system is at the GFR isolation valve.

In the MFPVs, the blended glass formers are mixed with the HLW concentrate to facilitate sampling. In order to prevent hydrogen buildup in the GFR addition line to the MFPV, there is an air purge line which ties into the GFR addition line following the GFR isolation valve [**3.5.3.12**]. The pressure difference between the feed hopper and the MFPV ensures airflow is cascading from a C3 to C5 zone.

4.1.1.1.3 HLW Melter Feed

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*
- *P&ID - HLW HLW Melter Feed Process System Melter Feed Vessel HFP-VSL-00002 - 24590-HLW-M6-HFP-00002001*

- *Mechanical Systems Data Sheet: Mechanical Agitator - 24590-HLW-MFD-HFP-00003*
- *HLW Vitrification Building General Arrangement Plan AT EL 0'-0" - 24590-HLW-P1-P01T-00002*

The HLW MFVs (HFP-VSL-00002/00006) receive blended melter feed, consisting of HLW concentrate and glass formers, from the HLW MFPVs. The batch cycle time for melter feed varies from 40 to 90 hours. The duration of the batch cycle times vary with the waste oxide loading, HLW solids concentration and glass yield.

The mechanical agitator in the MFV is capable of maintaining a homogeneous melter feed slurry to ensure the final product meets qualification requirements. Although the MFVs are not sampled during normal operations, they each have the capability to be sampled if required [**3.5.3.9**]. The mechanical agitator also ensures solids will be sufficiently disturbed to release entrained hydrogen from the vessel contents at a steady rate. To assist the agitator, baffles are located internal to the vessel. For further details on mechanical agitation and vessel internal baffles, refer to Section [**4.1.1.2.5**]. In the same manner as the MFPVs, spargers are located in the vessel to introduce an idle air purge to the system and help mitigate the possibility of hydrogen buildup. For further details on the spargers, refer to Section [**4.1.1.2.6**]. The gases purged to the vessel headspace are vented by the Process Vessel Vent Exhaust system during normal operations or the C5V ventilated melter cave during non-routine events.

The MFVs are equipped with the following:

- Mechanical agitator [**3.7.1.1.1**]
- Air spargers for purging hydrogen from vessel head space and agitation (on hold pending changes from SDS) [**3.10.1.3**]
- Air amplifier for Safety ventilation of the HFP head space [**3.11.2.1**]
- ADS transfer pumps [**3.9.1.2**]
- Demister on the vessel vent line for de-entrainment [**3.11.1.1**]
- Instrumentation for level, pressure, and density measurement [**3.10.1.1.2, 3.10.1.1.3**]
- Thermowell for temperature measurement [**3.10.1.1.1**]
- Cooling water jacket to remove radioactive decay heat and heat dissipated from agitation [**3.5.1.1.2**]
- Internal fixed nozzles for periodic wash-down [**3.5.3.5, 3.5.4.1**]
- Steam ejector for transfer to the plant wash and drains vessel (RLD-VSL-00008) [**3.5.3.8**]
- Overflow path, equipped with flapper valve to prevent air in-leakage [**3.5.2.1.1, 3.5.2.1.2**]
- Sample pump to transfer waste to auto sampler
- Internal baffles [**3.5.2.2**]

Each MFV is equipped with two ADS pumps for transfer to the melter; both pumps are needed to operate the melter at design throughput. Although sampling in the MFV is infrequent, each vessel is also equipped with a single cantilever centrifugal pump to support sampling (as opposed to the MFPVs which are equipped with 2 x 100% capacity pumps). The MFV design accommodates sampling but the centrifugal MFV sampling pump is not normally installed due to probability of plugging from infrequent use. Remote installation is required for installation of sampling capability. If sampling is conducted, the centrifugal pump transfers waste to the autosampling unit and recirculates the remaining waste back to the MFV.

The HLW MFVs are located in the melter cave. Removal and replacement of the vessel and its components is conducted remotely by the HLW Melter Cave Support Handling (HSH) System [**3.4.4.1**]. Due to the abrasive and

corrosive nature of the feed slurry, the agitator and pumps are anticipated to require replacement within the lifetime of the plant [**3.4.1.2.1**].

4.1.1.1.4 Vessel Ventilation

Each HFP vessel is equipped with a demister on the associated vent nozzle, which discharges into the PVV [**3.11.1.1**]. Prior to entering the PVV, the air passes from the vessel headspace into a demister. The demisters de-entrain the aerosols from the off-gases and purge air; the liquids and solids will be cleaned from the demister periodically using demineralized water and reagents as required, supplied to an internal wash ring provided above the demister packing. The flow of demineralized water is initiated manually by an operator to provide the demister flush. The ventilation serves as a form of protection to prevent accumulation of flammable gases that could result in a release of chemical or radiological material. The ventilation system maintains a negative pressure in the HFP vessels relative to other lower radiation/contamination zones so that in the event of a flow path forming, the direction of flow will be into the HFP vessel and then into the PVV.

During off-normal events such as loss of mixing or loss of vessel ventilation the vessels are equipped with air amplifiers to provide ventilation and maintain vessel headspace at negative pressure. The volume of air that can be drawn by the air amplifiers is sufficient to maintain vessel headspace at negative pressure during full sparging [**3.11.2.1.1**]. Air amplifiers, demisters, and demister packing are designed to be remotely removable and replaceable to accommodate 40 years of facility operation [**3.4.1.2.1**].

To maintain vessel headspace volume and prevent over pressurization due to excess liquids or gasses during an off-normal event, each HFP vessel is equipped with an overflow line and flapper valve to allow overflow to the melter sumps. The overflow mechanism is designed for the maximum in-flow rate of the vessels [**3.5.2.1.3**]. The overflow line includes a flapper valve which opens upon loss of negative headspace pressure, providing a backup vent path. This valve has been designed so that it does not fully seat when closed to prevent accumulation of solids [**3.5.2.1.2**]. The overflow line is directed towards the top of the melter cell sumps. The sumps, after appropriate jumper routing, transfer recovered spilled material to the opposite train's MFPV [**3.4.4.6**].

4.1.1.2 Components

In-Cave pipe work and vessels that are non-maintainable are fully welded [**3.6.1.1.1**]. HFP/HCP equipment is constructed of material resistant to radiation, process solutions, and decontamination agents. Selection of materials of construction addresses the in-cave chemical, radiological, and thermal environment to minimize maintenance requirements [**3.4.1.2.2**]. In-cell/cave equipment is simplified and minimized wherever practicable to improve reliability, operability, maintainability, and to minimize waste generated from disposal and decontamination. Maintainable equipment within the caves is designed for remote maintenance or to be recovered remotely by external means to a maintenance area [**3.4.4.1**]. Process piping in the HFP is designed to be free-draining with no traps/seals and vents/drains where appropriate to facilitate drainage [**3.6.4.1**]. Isolation and test points with drain/bleed valves shall be included in the design to allow for removal, replacement, and testing of plant items required during normal operations.

The predicted wear on type 316L stainless steel (unprotected by tungsten-carbide, cobalt based protective coating system) from slurries containing glass formers is based on an assumed slurry composed of 40 volume percent (60 weight percent) SIL-CO-SIL 75 silica sand composed of a weighted mean partiple diameter of 21 microns and maximum velocities of 3 m/s (assumptions 6.3, 6.4.3, and 6.5.2 of calculation 24590-WTP-M0C-50-00004). The predicted wear rate should be conservative since the solids in the WTP waste without glass formers are expected to be softer and less erosive than silica sand. The expected wear on the piping during operation is dependent on the velocity and the usage factor (see 24590-WTP-M0E-50-00011). If either the solids concentration or the weighted mean particle diameter of the WTP waste slurry is significantly greater than assumed in the calculation,

then the potential wear and useful life of the affected components containing glass formers should be recalculated [**3.4.1.2.2**].

Component safety classifications for components within this section are identified by requirement [**3.4.2.1**].

4.1.1.2.1 Air Displacement Slurry Pumps (HFP-PMP-00001 /-00002/-00014/-00015)

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*

The ADS pumps are used in the MFVs for transfer to the melter. The ADS pump type has been selected because it has self-clearing capabilities each stroke via an air flush. The driving force is compressed air from the ISA system, which acts to push the slurry using a pulsed flow and clears the feed lines at the same time [**3.9.1.2, 3.9.3.2.1**].

The ADS pump controls allow for a water flush cycle once every two to four hours during normal feeding operations. In addition, a flush cycle begins immediately before feeding starts from an idle condition and immediately after a pump shutdown condition to prevent feed line blockage. The flush water is sent to the melter. [**3.9.1.1.1, 3.9.3.1.1**]

The ADS pumps have a design life of greater than 5 years with normal periodic maintenance [**3.4.1.2.1**].

4.1.1.2.2 Cantilever Pumps (HFP-PMP-00005A/B / HFP-PMP-00018A/B / HFP-PMP-00007 /HFP-PMP-00017)

- *DRAWING - HLW Melter 1/2 Feed Preparation Vessel Assembly Drawing - 24590-QL-POA-MVA0-00018-03-00002*
- *Mechanical Systems Data Sheet; Vertical Centrifugal Pump - 24590-HLW-MPD-HFP-00007*
- *P&ID - HLW - HLW Melter Feed Process Sys Process System Sample/Transfer Pumps HFP-PMP-00005A/B - 24590-HLW-M6-HFP-00001002*

The HFP vessels are equipped with vertical centrifugal pumps for process fluid transfer and sampling. The MFPV cantilever pumps are used for both transfer and sampling functions while the MFV cantilever pump is only used for sampling. The MFPV and MFV cantilever pumps offer the capability to transfer melter feed to the opposite train through the respective sample loop. These pumps are mounted to the HFP vessels with bolted flanges and take suction from the bottom of the vessels. A priming line that connects at the suction entrance will prime the pump for pump start-up. The impeller and casing sit inside the vessel head. If the pump seals fail, the only path for waste is back into the vessel; thus preventing the vessel's liquids or gases from affecting personnel or the environment.

Each MFPV has two cantilever pumps for transfer to the MFV [**3.4.1.1.1**]. In addition to transfer of waste between vessels, the MFPV transfer pumps also provide the ability to sample by recirculating the slurry through the ASX sampler and back into their respective vessel [**3.4.1.1.3**]. Each MFV has a dedicated cantilever pump (HFP-PMP-00007/00017) for sampling, which has the ability to circulate vessel contents through the ASX sampler and back into its respective vessel. The MFV sampling pumps are not installed during normal operations, but they can be remotely installed when needed. Unlike the MFPVs which consistently use the sample/transfer lines and pumps for normal operations, the infrequent use of the MFV ASX pumps is postulated to contribute to build up of contaminants. The pumps are not normally installed to prevent plugs in the pump suction and priming lines due to long idle periods. Flushing of the transfer/sampling lines from these pumps is performed by flush connections in the ASX samplers. Flush connections have check and isolation valves to prevent back flow of process fluid into the utility system. [**3.9.1.1.1**]

The vertical centrifugal pumps are designed for a minimum service life of not less than 20 years (when subject to periodic maintenance) and an exposure life of 5 years (with no maintenance required in that period) [**3.4.1.2.1**].

4.1.1.2.3 Steam Ejectors (HFP-EJCTR-00001 and HFP-EJCTR-00002 / HFP-EJCTR-00005 and HFP-EJCTR-00004)

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*

The MFPVs and MFVs are both equipped with steam ejectors to assist in vessel decontamination and decommissioning (D&D). The steam ejectors will provide a route to the Plant Wash and Drains Vessel (RLD-VSL-00008) when the affected HFP vessel must be decommissioned. Steam ejectors are neither installed nor shall the steam supply be connected to the steam racks until required to support vessel D&D. This will prevent non-Newtonian waste from entering the RLD system. In order for the steam ejector to achieve the required lift, the vessel contents will require dilution with demineralized water because of the high solids content in the feed slurry [**3.4.4.4**]. Demineralized water is added to the vessels via an internal spray ring assembly. Initiation of vessel washing via the internal spray nozzles is achieved by manually opening a ball valve at the PWD rack for the associated vessel and controlling flow to the rack from the control room by adjusting the upstream PWD rack isolation valve.

4.1.1.2.4 Cooling Jackets

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*

The HFP vessels are equipped with cooling jackets. The cooling jackets are supplied with cooling water from the Plant Cooling Water (PCW) System in BOF. The cooling jackets have over-pressurization protection provided by pressure relief valves installed on the inlet cooling water lines that empty to the cave floor if the setpoint is exceeded. The PCW system is designed to provide adequate cooling for each HFP vessel to remove heat from mechanical agitation and radioactive decay. [**3.5.1.1.2**]

4.1.1.2.5 Mechanical Agitators

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*
- *Mechanical Systems Data Sheet; Mechanical Agitator - 24590-HLW-MFD-HFP-00013*

Both the MFPVs and MFVs utilize mechanical agitators to mix the HFP concentrate and glass formers to keep the solids in suspension [**3.7.1.1.1**]. The agitator also ensures the solids will be sufficiently disturbed to release entrained hydrogen from the vessel contents at a steady rate. The agitator is rotated by a variable speed drive motor and continuously operated. The agitator assemblies have speed sensors and current detectors for safety purposes to identify when the agitator fails [**3.10.1.2.1**]. The adjustable speed drive is utilized to vary the degree of mixing. Prior to sampling or processing forward melter feed, the agitator speed is increased to ensure a homogeneous mixture. During phases where the vessels are neither sampling nor transferring, the rate of agitator rotation is reduced such that erosion is reduced while keeping solids in suspension. The speed of the agitator can be increased or decreased manually by an operator and the controller will adjust the speed to achieve the desired output. The agitators for the MFPV vessels have WAI requirements to provide agitation sufficient to produce a homogenous mixture for sampling purposes. This WAI requirement is met by design configuration of the impellers and shaft assembly. Testing of the impeller configuration has verified satisfactory mixing as documented in Part B of the WAI Item Qualification Plan for HLW Melter Feed Preparation Vessel Agitators [**3.7.1.1.1**]. The MFPV speed sensors are calibrated to meet WAI requirements for verifying appropriate rotational speed needed to guarantee homogeneity. Administrative controls are required to confirm rotational speed and mixing time, greater than 15 minutes, prior to vessel sampling.

The MFPVs and MPVs are equipped with four baffles placed around the vessel internal perimeter. These baffles are supported in four points along their height off the vessel wall and have a gap between the vessel wall and the baffle. This arrangement enhances the mixing of the agitator and minimizes the coning effect of the operation of the agitator. The dimensions and placement of these baffles, as well as the rest of the internal geometry in the vessels, are WAI because the baffles and vessel internals influence the effectiveness of the mixing required to obtain representative samples.[**3.5.2.2**].

4.1.1.2.6 Sparge Tubes

- *DRAWING - HLW Melter 1/2 Feed Preparation Vessel Assembly Drawing - 24590-QL-POA-MVA0-00018-03-00002*

The air sparging system in the HFP vessels provides hydrogen mitigation capability. Current design of the HFP system includes sparge tubes for hydrogen mitigation and a redundant method to prevent a Design Basis Gas Release Event (DBGRE). The SDS identifies the sparge tube design as removed and references development of alternate methods of performing these functions. Pending development of these alternate methods and their incorporation into the design basis documents, the requirements for air sparging are on hold [**3.10.1.3.2**].

There will be eight spargers radially located around the vessel. In the current design, the air sparge tubes provide a forced airflow during normal operations with the agitator running to ensure there will not be a slow buildup of hydrogen in the vessel headspace above the Lower Flammability Limit (LFL) [**3.8.2.1**]. During Design Basis Events resulting in agitator failure, full safety sparge mode is initiated and the sparge tube airflow is increased to disturb the sediment layer formed by the settling solids and allow the hydrogen trapped by this layer to be released prior to reaching the LFL or a gas concentration sufficient to induce a cascade bubble release [**3.8.3.2**]. During the safety sparge mode, the spargers flow rate will be increased intermittently approximately once per day for one hour, returning to normal operating purge flow after that hour. The sparge air is vented from the vessel into the Process Vessel Vent Exhaust (PVV) system except when the sparging is activated by the seismic signal. When activated by the seismic signal, the air amplifiers mounted on the vessel head also activate ejecting the headspace air into the C5 melter cell to prevent over pressurization of the vessel. The air supply piping and valves within the air sparging system are designed as Safety Class components [**3.4.2.1**].

4.1.1.2.7 Steam Racks

- *P&ID - HLW - HLW Melter Feed Process System Sparge Rack Utility Supplies - 24590-HLW-M6-HFP-00010001*

The steam racks in the HFP and HCP feed high-pressure steam to ejectors in the RLD, HSH, and HFP systems. Steam is supplied by the HPS. Steam will not be attached to the steam supply piping until decommissioning. The ISA provides pressurized air used to purge steam lines following a steam transfer to prevent a steam collapse, which would result in backflow of contamination.

4.1.2 Boundaries and Interfaces

- *Process Flow Diagram HL W Receipt & Feed Preparation (System HCP, GFR, & HFP) - 24590-HLW-M5-V17T-00001*

The major interfaces with the HFP system are the HLW Concentrate Receipt Process System (HCP), HLW Melter Process System (HMP), and Glass Former Reagent (GFR) System. The Melter Feed Preparation Vessels receive HLW concentrate from the Pretreatment HLP system through the HCP system. The process waste enters to HCP system from the PT facility HLP system before entering the HFP system where GFRs are added an ultimately fed to the HMP system melters.

The boundary of the HCP system is at the wall of the melter cave. The HFP boundary limit with the GFR system is at the isolation valve downstream of the HLW Glass Former Mixer on the discharge line to the MFPV. From the Melter Feed Vessel, HLW feed slurry is transferred to the HMP system. The boundary limit with the HMP system is at the melter nozzle. The boundaries for manually operated processes are at the wallbox. The boundaries for controlled processes are at the control valve. Agitators and pumps receive their power from the motor control centers. Power for the instrumentation and control systems will be from the plant Safety Uninterruptible Power Electrical System (UPS). Safety Power for the agitators is supplied by the standby diesel generators. The HFP vessels and vessel equipment can be remotely removed and replaced by the mechanical handling equipment in the melter cave. The radioactive solid waste handling (RWH) system equipment and processes are used to change out the HFP pumps, agitators, and other miscellaneous equipment. [**3.5.3.1, 3.5.3.2, 3.5.3.3, 3.5.3.4**]

4.1.2.1 Interfacing Systems

Table 4–1 System Interfaces

System Locator	System Name	Nature of Interface
ASX	Autosampling System	Sampling is performed to characterize the batch waste. The HFP waste batch is pumped through a recirculation loop to an autosampling unit. The autosampler is located outside the cell in a shielded but accessible location. After progressing through the autosampling unit, waste recirculates back to the MFPV. [3.5.3.9]
C5V	C5 Ventilation System	During off-normal events, provides ventilation of the melter cave to remove headspace gas vented by the HFP vessel air amplifiers or overflow features when the HOP/PVV is unavailable.
DIW	Demineralized Water System	Demineralized water is supplied for vessel washing; and to flush the Transfer and ADS pumps. [3.5.3.5]
GFR	Glass Formers Reagent System	The GFR Feed Hopper delivers blended glass formers to the HFP system vessels.
HCP	HLW Concentrate Receipt Process System	Provides a transfer path to supply HLW concentrate to MFPVs from PT HLP.
HFP	HLW Melter Feed Process System	Receives feed concentrate from HCP.
HLP	HLP Lag Storage and Feed Blending System	Transfers HLW concentrate from the PT Facility to the HLW HCP.
HMP	HLW Melter Process System	Receives blended HLW feed from the MFVs.
HOP	HLW Primary Offgas System	Negative headspace pressure is maintained in the HFP vessels by the PVV and HOP systems.
HPS	High Pressure Steam System	Supplies steam to the steam ejectors in the HFP vessels and sump.
HSH	Melter Cave Support Handling System	Facilitates change out of all HFP equipment, including HFP vessels, and performs maintenance within the melter caves.

Table 4–1 System Interfaces

System Locator	System Name	Nature of Interface
ISA/ Safety ISA	Instrument Service Air System	The safety ISA provides air for vessel sparging/purging, GFR line purging, air supply to the air amplifiers (when activated), as well as motive force to operate pneumatically operated safety valves. The non-safety ISA supplies instrument air to non-safety HFP instruments, control valves, and ADS pumps.
LVE	Low Voltage Electrical System	Supplies electrical power for normal operation of pumps and agitators.
NAR	Nitric Acid Reagent System	Supplies 0.5M and 2M nitric acid for decontamination activities.
PCJ	Process Control System	Monitor and basic process control.
PCW	Plant Cooling Water System	Supplies cooling water to the HFP vessel cooling jackets. [3.5.3.6.1]
PPJ	Programmable Protection System	Monitor and safety control.
PVV	Process Vessel Vent Exhaust System	Maintains a negative pressure in the HFP vessels and vents the vessel off-gas to the melter off-gas treatment process system (HOP). [3.5.3.7.1]
PWD	Plant Wash and Disposal System	Supplies demineralized water to HFP vessels for washdowns, concentrate dilution, to prime sample/transfer pumps. The PT Facility vessel PWD-VSL-00043 receives flush water from the HLW concentrate transfer line from PT HLP to MFPV.
RLD	Radioactive Liquid Waste Disposal System	Receives HFP vessel wash effluent during decommissioning and recycles back to the PT facility.
UPE	Uninterruptible Power Electrical System	Supplies back-up power for Safety SSCs requiring electrical power.

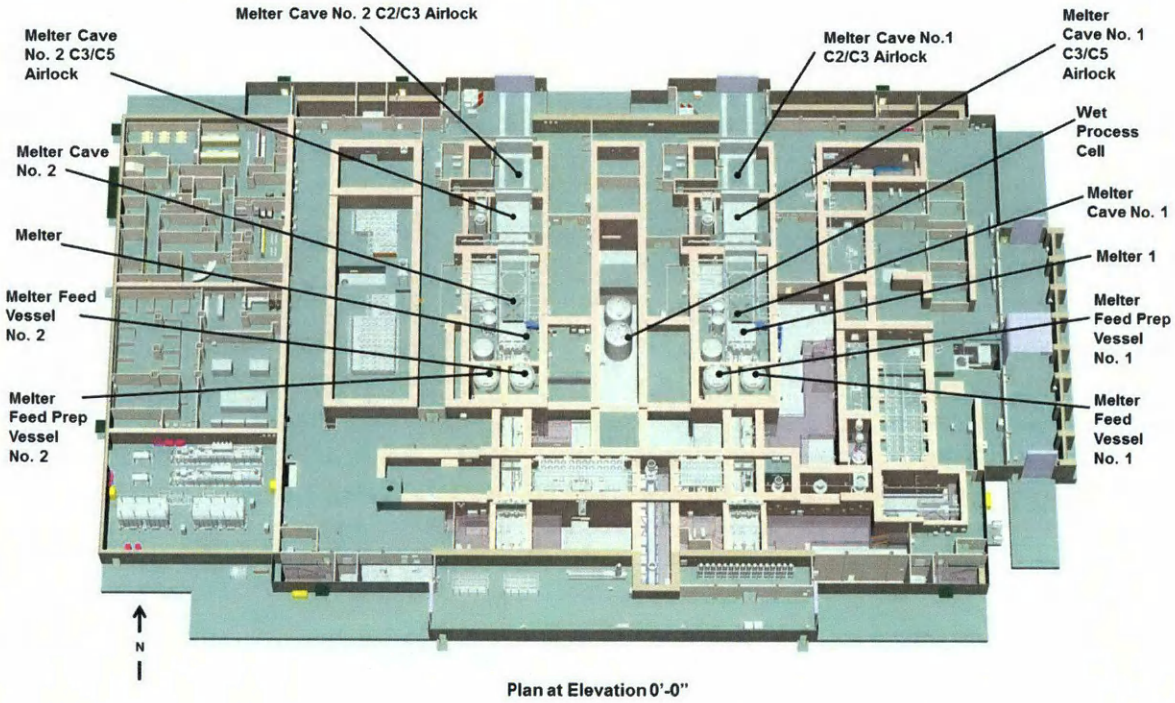
4.1.3 Physical Layout and Location

- *HLW Vitrification Building General Arrangement Plan AT EL 0'-0" - 24590-HLW-P1-P01T-00002*
- *HLW Vitrification Building General Arrangement Plan AT EL 58'-0" - 24590-HLW-P1-P01T-00005*

The majority of the HFP process equipment is primarily housed in the melter caves 1 (H-0117) and 2 (H-0106) which starts at elevation 0 ft and extends up through elevation +14 ft. The melter cells are classified as C5/R5 zones within the HLW Facility. Primary containment for waste is the process vessels, piping, and vessel ventilation; the secondary containment for waste is the cell, the cell liners, and sumps. Equipment manipulated by operations located in the melter caves is normally remotely performed in the HLW main control room. Equipment is laid out and valved such that when maintenance needs to be performed, minimum nominal amount of other components/systems are impacted. Melter caves 1 and 2 are equipped with wash rings used for cell decontamination, if required. Process and utility piping shall have a means to prevent or mitigate cross contamination. Demineralized water and other reagents can be attached to the wash racks for use in decontamination and maintenance activities. The utility racks and control racks for the HCP and HFP are located

on elevation 58 ft,in rooms H-424 and H-426. These rooms are designated as C2/C3/R2 zones. The radioactive solid waste handling system (RWH) mechanical handling components are relied on for maintenance and replacement activities of process equipment. The maintainable equipment is constructed to be removable using HSH remote mechanical handling equipment. Cell contamination level is indicated on general arrangement drawings. In-cave equipment is designed to minimize contamination and have features to aid in decontamination. All equipment and cells that house them are designed to withstand the chemical properties of the waste and the decontamination process. The figure 4-3 shows a simplified plan view of the HLW Facility.

Figure 4–3 HLW Facility Plan at Elevation 0 ft



4.1.4 Principles of Operation

The HLW Concentrate Receipt Process system receives HLW concentrate through waste transfer lines from the PT HLW feed blend vessel (HLP-VSL-00028) of the HLW Lag Storage and Blending Process System (HLP), and transfers the waste to Melter Feed Preparation Vessels (MFPV) of the HFP system. The HLW concentrates from PT are transferred to the MFPVs through four separate lines. Of the four transfer lines, two are dedicated for each melter. The HFP system receives, blends, samples, and transfers the waste slurry to the melter. In the MFPV (HFP-VSL-00001/00005), HLW concentrate (solids from ultrafiltration, strontium/transuranic (TRU) precipitate, cesium concentrate and Cs/Sr capsule (future waste)) and glass formers are combined to make HLW melter feed slurry. The required amount of glass former addition is calculated based upon the samples recovered from the system.. Glass formers are added to the MFPV by gravity transfer. The blended melter feed is then batch-transferred to the MFV (HFP-VSL-00002/00006), where it is continuously transferred to the HLW melters. Each vessel is equipped with two air displacement slurry pumps for transfer to the melter; both pumps are needed to operate the melter. Although sampling in the MFV is infrequent, the vessel is equipped with a cantilever pump for sampling. If melter feed in the MFPV is determined unsatisfactory for progression to the MFV due to

sampling results, the batch is adjusted with the glass formers to allow processing. If the required addition of glass formers exceeds the volume of the MFPV, then transfer between the melter trains is allowed.

During normal operations waste transfer is directed to the MFPV, followed by a single line volume of flush into MFPV. Subsequent line flushes are directed back to the PT Facility (PWD-VSL-00043) via the other transfer line to minimize waste dilution.

The HLW melter feed process system consists of two trains with each train serving a dedicated melter. Each HFP train consists of a HLW Glass Former Mixer, a Melter Feed Preparation Vessel, a Melter Feed Vessel, and associated equipment.

Additional discussion of system operations is provided in Section 4.2.

4.1.5 System Reliability Features

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4.1.6 System Control Features

The PPJ and PCJ system is a plant-wide system for monitoring and control of the process, ventilation, and services within the PT, HLW, and LAW facilities. The PPJ and PCJ are an integral part of the Integrated Control Network and provides the following functions:

- Monitoring of independent protection trips
- Device interlocks

The PPJ and PCJ also provide startup initiation, status monitoring, and shutdown initiation of independently controlled services and utilities. This allows remote operation of the equipment located in-cave/cell.

The MFPVs, MFVs, and ASD control racks are equipped with instrumentation. The data is collected by the sensing elements, which are located in the vessels and control racks. The signals are sent to the transmitters, which are located in instrument racks on elevation 37 ft. The primary control location for HLW Facility will be the control room (H-A201) located at elevation +14 ft of the HLW building. In-cell operations is operated remotely from this room.

4.1.6.1 System Monitoring

This Section is on hold pending C&I determination of Packaged Equipment control requirements and Complex Control Schemes.

4.1.6.2 Control Capability and Locations

Control capability and locations will be identified in a configuration data index (CDI) (24590-HLW-JDX-HFP-0001 future) which will be provided by C&I at a later date.

4.1.6.3 Automatic and Manual Actions

The table below identifies the manual actions for the HLW HFP System:

Table 4–2 Manual Actions for the HLW HFP System

Equipment No.	Instrument No.	Function	Remarks
HFP-VSL-00001 (Melter 1 Feed Preperation Vessel)	HFP-HK-0051B	Operator Adjusted Setpoint for HFP-VSL-00001 Feed Batch Volume (HFP-LT-0051)	
HFP-PMP-00005A	HFP-HK-0113	Operator Adjusted Set point for HFP-PMP-00005A Totalized Flow (HFP-FT-0113)	
	HFP-HC-0037	Controls pump HFP-PMP-00005A by Varying Pump Speed	
HFP-PMP-00005B	HFP-HK-0114	Operator Adjusted Setpoint for HFP-PMP-00005B Totalized Flow (HFP-FT-0114)	
	HFP-HC-0038	Controls pump HFP-PMP-00005B by Varying Pump Speed	
HFP-PMP-00007	HFP-HC-0042	Controls pump HFP-PMP-00007 by Varying Pump Speed	
HFP-AGT-00001	HFP-HC-0011	Controls HFP-AGT-00001 by Varying Agitator Speed	
HFP-AGT-00002	HFP-HC-0018	Controls HFP-AGT-00002 by Varying Agitator Speed	
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-HK-2051B	Operator Adjusted Setpoint for HFP-VSL-00005 Feed Batch Volume (HFP-LT-2051)	
HFP-PMP-00018A	HFP-HK-2113	Operator Adjusted Setpoint for HFP-PMP-00018A Totalized Flow (HFP-FT-2113)	
	HFP-HC-2037	Controls pump HFP-PMP-00018A by Varying Pump Speed	
HFP-PMP-00018B	HFP-HK-2114	Operator Adjusted Setpoint for HFP-PMP-00018B Totalized Flow (HFP-FT-2114)	
	HFP-HC-2038	Controls pump HFP-PMP-00018B by Varying Pump Speed	

Table 4–2 Manual Actions for the HLW HFP System

Equipment No.	Instrument No.	Function	Remarks
HFP-PMP-00017	HFP-HC-2042	Controls pump HFP-PMP-00017 by Varying Pump Speed	
HFP-AGT-00004	HFP-HC-2011	Controls HFP-AGT-00004 by Varying Agitator Speed	
HFP-AGT-00005	HFP-HC-2018	Controls HFP-AGT-00005 by Varying Agitator Speed	

The table below identifies the automatic actions for the HLW HFP System:

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
HFP-VSL-00001 (Melter 1 Feed Preparation Vessel)	HFP-YC-0105A		Opens and Closes valve HFP-YV-0105, Glass Former Addition Valve via HFP- YY-0105A	On Hold Pending Development of Glass Former Addition
	HFP-YC-0105B	SC	Opens and Closes valve HFP-YV-0105, Glass Former Addition Valve via HFP- YY-0105B	On Hold Pending Development of Glass Former Addition
	HFP-YC-0105C	SC	Opens and Closes valve HFP-YV-0105, Glass Former Addition Valve via HFP- YY-0105C	On Hold Pending Development of Glass Former Addition
	HFP-YC-0102		Opens and Closes valve HFP-YV-0102, Demister Flush Valve	
	HFP-YC-0103A		Opens and Closes valve HFP-YV-0103, HFP-VSL-00001 Pretreatment Isolation Valve, via HFP-YY-0103A	
	HFP-YC-0103B	SC	Opens and Closes valve HFP-YV-0103, HFP-VSL-00001 Pretreatment Isolation Valve, via HFP-YY-0103B	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-0049		Opens and Closes valve HFP-YV-0049.	
	HFP-HS-0049A		Starts and Stops HFP-EJCTR-00001 Operating Sequence	
	HFP-YC-0923		Opens and Closes HFP-YV-0923. HFP- RK.-00016 Sparge Tube Flush Valve	
	HFP-YC-0929	SC	Opens and Closes HFP-YV-0929, HFP-RK.-00016 Sparge Tube Flush Valve	
	HFP-YC-0930	SC	Opens and Closes HFP-YV-0930. HFP-RK.-00016 Sparge Tube Flush Valve	
	HFP-YC-0925	SC	Opens and Closes HFP-YV-0925. Air Amplifier Supply Valve	
	HFP-YC-0928	SC	Opens and Closes HFP-YV-0928. Air Amplifier Supply Valve	
	HFP-YC-0903	SC	Opens and Closes HFP-YV-0903, Air Sparging Valve	
HFP-VSL-00001 (Melter 1 Feed Preparation Vessel)	HFP-YC-0904	SC	Opens and Closes HFP-YV-0904. Air Sparging Valve	
	HFP-YC-0931	SC	Opens and Closes HFP-YV-0931. Safety Air Crossover Valve	
	HFP-YC-0932	SC	Opens and Closes HFP-YV-0932. Safety Air Crossover Valve	
HFP-PMP-00005A (Melter 1 Feed Preparation Vessel Sample/Transfer Pump)	HFP-HS-0115		Pump HFP-PMP-00005A Priming Sequence Start Switch	
	HFP-YC-0037		Starts and Stops HFP-PMP-00005A	
	HFP-YC-0106A	SC	Starts and Stops HFP-PMP-00005A via HFP-JY-0106A	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-0106B	SC	Starts and Stops HFP-PMP-00005A via HFP-JY-0106B	
	HFP-YC-0002		Opens and Closes valve HFP-YV-0002. HFP-PMP-00005A Priming Valve	
	HFP-YC-0039		Opens and Closes Valve HFP-YV-0039. HFP-PMP-00005A Flow Path Control Valve	
HFP-PMP-00005B (Melter 1 Feed Preparation Vessel Sample/Transfer Pump)	HFP-HS-0116		Pump HFP-PMP-00005B Priming Sequence Start Switch	
	HFP-YC-0038		Starts and Stops HFP-PMP-00005B	
	HFP-YC-0107A	SC	Starts and Stops HFP-PMP-00005B via HFP-JY-0107A	
	HFP-YC-0107B	SC	Starts and Stops HFP-PMP-00005B via HFP-JY-0107B	
	HFP-YC-0003		Opens and Closes valve HFP-YV-0003. HFP-PMP-00005B Priming Valve	
	HFP-YC-0040		Opens and Closes valve HFP-YV-0040. HFP-PMP-00005B Flow Path Control Valve	
HFP-VSL-00002 (Melter 1 Feed Vessel)	HFP-YC-0024		Opens and Closes valve HFP-YV-0024. Demister Flush Valve	
	HFP-YC-0033		Opens and Closes valve HFP-YV-0033. HFP-EJCTR-00002 Ejector Valve	
	HFP-YC-0013A	SC	Opens and Closes valve HFP-YV-0013A. bubbler Air/Water Supply Valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-0013B	SC	Opens and Closes valve HFP-YV-0013B, bubbler Air/Water Supply Valve	
HFP-VSL-00002 (Melter 1 Feed Vessel)	HFP-HS-0033A		Starts and Stops HFP-EJCTR-00002 Operating Sequence	
	HFP-YC-1023		Opens and Closes HFP-YV-1023, HFP-RK-00017 Sparge Tube Flush Valve	
	HFP-YC-1029	SC	Opens and Closes HFP-YV-1029, HFP- RK-00017 Sparge Tube Flush Valve	
	HFP-YC-1030	SC	Opens and Closes HFP-YV-1030, HFP-RK-00017 Sparge Tube Flush Valve	
	HFP-YC-1025	SC	Opens and Closes HFP-YV-1025, Air Amplifier Supply Valve	
	HFP-YC-1028	SC	Opens and Closes HFP-YV-1028, Air Amplifier Supply Valve	
	HFP-YC-1003	SC	Opens and Closes HFP-YV-1003, Air Sparging Valve	
	HFP-YC-1004	SC	Opens and Closes HFP-YV-1004, Air Sparging Valve	
	HFP-YC-1031	SC	Opens and Closes HFP-YV-1031, Safety Air Crossover Valve	
	HFP-YC-1032	SC	Opens and Closes HFP-YV-1032, Safety Air Crossover Valve	
HFP-PMP-00007 (Melter 1 Feed Vessel Sample Pump)	HFP-HS-0117		Pump HFP-PMP-00007 Priming Sequence Start Switch	
	HFP-YC-0042		Starts and Stops HFP-PMP-00007	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-0203A	SC	Starts and Stops HFP-PMP-00007 via HFP-JY-0203A	
	HFP-YC-0203B	SC	Starts and Stops HFP- MP-00007 via HFP-JY-0203B	
	HFP-YC-0022		Opens and Closes valve HFP-YV-0022, HFP-PMP-00007 Priming Valve	
HFP-PMP-00001/2 (Melter 1 Feed Vessel ADS Pumps)	HFP-FC-0034E		Controls Water Flow by Modulating HFP-FV-0034E	
	HFP-FC-0035E		Controls Water Flow by Modulating HFP-FV-0035E	
	HFP-YC-0057		Opens and Closes valve HFP-YV-0057, HFP-PMP-00001/2 Instrument Service Air Header Valve	
	HFP-YC-0034A		Opens and Closes HFP-YC-0034A, HFP-PMP-00001 Poppet Control	
	HFP-YC-0034B		Opens and Closes HFP-YC-0034B, HFP-PMP-00001 Air Supply Valve	
	HFP-YC-0034C		Opens and Closes HFP-YC-0034C, HFP-PMP-00001 Air/Water Supply Valve	
	HFP-YC-0034D		Opens and Closes HFP-YC-0034D, HFP-PMP-00001 Air Supply valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-0034E		Opens and Closes HFP-YC-0034E, Melter 1 West Nozzle Water Supply Valve	
	HFP-YC-0034F		Opens and Closes HFP-YC-0034F, HFP-PMP-00001 Air Supply valve	
	HFP-HS-0034E		Starts and Stops HFP-PMP-00001 Operating Sequence	
	HFP-YC-0035A		Opens and Closes HFP-YC-0035A, HFP-PMP-00002 Poppet Control	
	HFP-YC-0035B		Opens and Closes HFP-YC-0035B, HFP-PMP-00002 Air Supply Valve	
	HFP-YC-0035C		Opens and Closes HFP-YC-0035C, HFP-PMP-00002 Air/Water Supply Valve	
	HFP-YC-0035D		Opens and Closes HFP-YC-0035D, HFP-PMP-00002 Air Supply Valve	
	HFP-YC-0035E		Opens and Closes HFP-YC-0035E, HFP-PMP-00002 Nozzle Water Supply Valve	
	HFP-YC-0035F		Opens and Closes HFP-YC-0035F, HFP-PMP-00002 Air Supply Valve	
	HFP-HS-0035E		Starts and Stops HFP-PMP-00002 Operating Sequence	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
HFP-AGT-00001 (Melter 1 Feed Preparation Vessel Agitator)	HFP-YC-0011		Starts and Stops HFP-AGT-00001	
HFP-AGT-00002 (Melter 1 Feed Vessel Agitator)	HFP-YC-0018		Starts and Stops HFP-AGT-00002	
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-YC-2105A		Opens and Closes valve HFP-YV-2105. Glass Former Addition Valve via HFP- YY-2105A	On Hold Pending Development of Glass Former Addition
	HFP-YC-2105B	SC	Opens and Closes valve HFP-YV-2105. Glass Former Addition Valve via HFP- YY-2105B	On Hold Pending Development of Glass Former Addition
	HFP-YC-2105C	SC	Opens and Closes valve HFP-YV-2105. Glass Former Addition Valve via HFP- YY-2105C	On Hold Pending Development of Glass Former Addition
	HFP-YC-2102		Opens and Closes valve HFP-YV-2102. Demister Flush Valve	
	HFP-YC-2103A		Opens and Closes valve HFP-YV-2103 via HFP-YY-2103A	
	HFP-YC-2103B	SC	Opens and Closes valve HFP-YV-2103 via HFP-YY-2103B	
	HFP-YC-2049		Opens and Closes valve HFP-YV-2049. HFP-EJCTR-00003 Ejector Valve	
	HFP-HS-2049A		Starts and Stops HFP-EJCTR-00005 Operating Sequence	
	HFP-YC-2923		Opens and Closes HFP-YV-2923, HFP-RK-00018 Sparge Tube Flush Valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-2929	SC	Opens and Closes HFP-YV-2929, HFP-RK-00018 Sparge Tube Flush Valve	
	HFP-YC-2930	SC	Opens and Closes HFP-YV-2930, HFP-RK-00018 Sparge Tube Flush Valve	
	HFP-YC-2925	SC	Opens and Closes HFP-YV-2925, Air Amplifier Supply Valve	
	HFP-YC-2928	SC	Opens and Closes HFP-YV-2928, Air Amplifier Supply Valve	
	HFP-YC-2903	SC	Opens and Closes HFP-YV-2903, Air Sparging Valve	
	HFP-YC-2904	SC	Opens and Closes HFP-YV-2903, Air Sparging Valve	
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-YC-2931	SC	Opens and Closes HFP-YV-2931, Safety Air Crossover Valve	
	HFP-YC-2932	SC	Opens and Closes HFP-YV-2932, Safety Air Crossover Valve	
	HFP-YC-2008A	SC	Opens and Closes HFP-YV-2008A, Bubbler Air/Water Supply Valve	
	HFP-YC-2008B	SC	Opens and Closes HFP-YV-2008B, Bubbler Air Supply Valve	
	HFP-YC-2013A	SC	Opens and Closes HFP-YV-2013A, Bubbler Air/Water Supply Valve	
	HFP-YC-2013B	SC	Opens and Closes HFP-YV-2013B, Bubbler Air Supply Valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
HFP-PMP-00014/15 (Melter 2 Feed Vessel ADS Pumps)	HFP-FC-2034E		Controls Water Flow by Modulating HFP-FV-2034E	
	HFP-FC-2035E		Controls Water Flow by Modulating HFP-FV-2035E	
	HFP-YC-2034A		Opens and Closes HFP-YV-2034A, HFP-PMP-00014 Poppet Control	
	HFP-YC-2034B		Opens and Closes HFP-YV-2034B, HFP-PMP-00014 Air Supply Valve	
	HFP-YC-2034C		Opens and Closes HFP-YV-2034C, HFP-PMP-00014 Air/Water Supply Valve	
	HFP-YC-2034D		Opens and Closes HFP-YV-2034D, HFP-PMP-00014 Air Supply Valve	
	HFP-YC-2034E		Opens and Closes HFP-YV-2034E, Melter 2 West Nozzle Water Supply Valve	
	HFP-YC-2034F		Opens and Closes HFP-YV-2034F, HFP-PMP-00014 Air Supply Valve	
	HFP-HS-2034E		Starts and Stops HFP-PMP-00014 Operating Sequence	
	HFP-YC-2035A		Opens and Closes HFP-YV-2035A, HFP-PMP-00015 Poppet Control	
	HFP-YC-2035B		Opens and Closes HFP-YV-2035B, HFP-PMP-00015 Air Supply Valve	
	HFP-YC-2035C		Opens and Closes HFP-YV-2035C, HFP-PMP-00015 Air/Water Supply Valve	
	HFP-YC-2035D		Opens and Closes HFP-YV-2035D, HFP-PMP-00015 Air Supply Valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-2035E		Opens and Closes HFP-YV-2035E, Melter 2 East Nozzle Water Supply Valve	
	HFP-YC-2035F		Opens and Closes HFP-YV-2035F, HFP-PMP-00015 Air Supply Valve	
	HFP-HS-2035E		Starts and Stops HFP-PMP-00015 Operating Sequence	
HFP-PMP-00018A (Melter 2 Feed Preparation Vessel Sample/Transfer Pump)	HFP-HS-2115		Pump HFP-PMP-00018A Priming Sequence Start Switch	
	HFP-YC-2037		Starts and Stops HFP-PMP-00018A	
	HFP-YC-2106A	SC	Starts and Stops HFP-PMP-00018A via HFP-JY-2106A	
	HFP-YC-2106B	SC	Starts and Stops HFP-PMP-00018A via HFP-JY-2106B	
	HFP-YC-2002		Opens and Closes valve HFP-YV-2002, HFP-PMP-00018A Priming Valve	
	HFP-YC-2039		Opens and Closes valve HFP-YV-2039, HFP-PMP-00018A Flow Path Control Valve	
HFP-PMP-00018B (Melter 2 Feed Preparation Vessel Sample/Transfer Pump)	HFP-HS-2116		Pump HFP-PMP-00018B Priming Sequence Start Switch	
	HFP-YC-2038		Starts and Stops HFP-PMP-00018B	
	HFP-YC-2107A	SC	Starts and Stops HFP-PMP-00018B via HFP-JY-2107A	
	HFP-YC-2107B	SC	Starts and Stops HFP-PMP-00018B via HFP-JY-2107B	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-2003		Opens and Closes valve HFP-YV-2003, HFP-PMP-00018B Priming Valve	
	HFP-YC-2040		Opens and Closes valve HFP-YV-2040, HFP-PMP-00018B Flow Path Control Valve	
HFP-VSL-00006 (Melter 2 Feed Vessel)	HFP-YC-2024		Opens and Closes valve HFP-YV-2024, Demister Flush Valve	
	HFP-YC-2033		Opens and Closes valve HFP-YV-2033, HFP-EJCTR-00004 Ejector Valve	
	HFP-HS-2033A		Starts and Stops HFP-EJCTR-00004 Operating Sequence	
HFP-VSL-00006 (Melter 2 Feed Vessel)	HFP-YC-3023		Opens and Closes HFP-YV-3023, HFP-RK.-00017 Sparge Tube Flush Valve	
	HFP-YC-3029	SC	Opens and Closes HFP-YV-3029, HFP-RK.-00019 Sparge Tube Flush Valve	
	HFP-YC-3030	SC	Opens and Closes HFP-YV-3030, HFP-RK.-00019 Sparge Tube Flush Valve	
	HFP-YC-3025	SC	Opens and Closes HFP-YV-3025, Air Amplifier Supply Valve	
	HFP-YC-3028	SC	Opens and Closes HFP-YV-3028, Air Amplifier Supply Valve	
	HFP-YC-3003	SC	Opens and Closes HFP-YV-3003, Air Sparging Valve	
	HFP-YC-3004	SC	Opens and Closes HFP-YV-3004, Air Sparging Valve	

Table 4–3 Automatic Actions for the HLW HFP System

Equipment No.	Instrument No.	Properties	Function	Remarks
	HFP-YC-3031	SC	Opens and Closes HFP-YV-3031, Safety Air	
	HFP-YC-3032	SC	Opens and Closes HFP-YV-3032, Safety Air Crossover Valve	
HFP-PMP-00017 (Melter 2 Feed Vessel Sample Pump)	HFP-HS-2117		Pump HFP-PMP-00017 Priming Sequence Start Switch	
	HFP-YC-2042		Starts and Stops HFP-PMP-00017	
	HFP-YC-2203A	SC	Starts and Stops HFP-PMP-00017 via HFP-JY-2203A	
	HFP-YC-2203B	SC	Starts and Stops HFP-PMP-00017 via HFP-JY-2203B	
	HFP-YC-2022		Opens and Closes valve HFP-YV-2022, HFP-PMP-00017 Priming Valve	
HFP-PMP-00003/4 (Melter 2 Feed Vessel ADS Pumps)	HFP-YC-2057		Opens and Closes valve HFP-YV-2057, HFP-PMP-00003/4 Instrument Service Air Header Valve	
HFP-AGT-00004 (Melter 2 Feed Preparation Vessel Agitator)	HFP-YC-2011		Starts and Stops HFP-AGT-00004	
HFP-AGT-00005 (Melter 2 Feed Vessel Agitator)	HFP-YC-2018		Starts and Stops HFP-AGT-00005	

4.1.6.4 Setpoints and Ranges

Alarm setpoints and process trips will be identified in a configuration data index (CDI) (24590-HLW-JDX-HFP-00001 future) which will be provided by C&I at a later date. Safety instrumented function trip setpoints will be identified in the associated safety system requirements specification for the specific safety instrumented function.

4.1.6.5 Interlocks, Bypasses, and Permissives

Interlocks, Bypasses, and Permissives will be identified in a configuration data index (CDI) (24590-HLW-JDX-HFP-0001 future) which will be provided by C&I at a later date.

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-VSL-00001 (Melter 1 Feed Preparation Vessel)	HFP-LI-0051_BQ (HFP-LT-0051)		HFP-LT-0051 Bad Quality: • Override Closes HFP-YV-0002 • Override Closes HFP-YV-0003 • Override Closes HFP-YV-0102 • Override Closes HFP-YV-0923 • Override Closes PWD-YV-0021 • Stops HFP-EJCTR-00001 Sequence • Override Stops HFP-AGT-00001 • Override Stogs HFP-PMP-00005AIB	
	HFP-LSH-0051 (HFP-LT-0051)		Switches volume calculation equations from equation f(x)1 for flanged bottom calculations to equation f(x)2 for inches to gallons conversion in the entire tank	
	HFP-LSHH-0051A (HFP-LT-0051)		HFP-VSL-00001 Level High High • Override Closes HFP-YV-0105 via HFP-YY-0105A • Override Closes HFP-YV-0002 • Override Closes HFP-YV-0003 • Override Closes HFP-YV-0102 • Override Closes HFP-YV-0103 via HFP-YY-0103A • Override Closes HFP-YV-0923 • Override Closes PWD-YV-0021	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSH-0051B (HFP-LT-0051)		HFP-VSL-00001 Transfer Volume High: • Override Closes HFP-YV-0103 • Override Stogs HLP-PMP-00019B	
	HFP-LSLL-0051A (HFP-LT-0051)		HFP-VSL-00001 Level Low Low: • Stops HFP-EJCTR-00001 Sequence • Override Stops HFP-AGT-00001 • Override Stops HFP-PMP-00005A/B	
	HFP-TSHH-0010 (HFP-TT-0010)		HFP-VSL-00001 Temperature High High Override Closes HFP-YV-0103	
	HFP-YC-0105A CLSD		HFP-VSL-00001 Glass Former Addition Valve Not Closed Override Closes HFP- YV-0103	
	HFP-YC-0103A CLSD		HFP-VSL-00001 Pretreatment Isolation Valve Not Closed Override Closes HFP- YV-0105	
HFP-VSL-00001 (Melter 1 Feed Preparation Vessel)	HFP-PSHH-0052 (HFP-PT-0052)	SS	HFP-VSL-00001 Pressure High High Override Closes HFP-YV-0105 via HFP- YY-0105B	
			HFP-VSL-00001 Pressure High High Override Closes HFP-YV-0105 via HFP- YY-0105A	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSHH-0050 (HFP-LT-0050)	SC	HFP-VSL-00001 Level High High • Override Closes HFP-YV-0105 via HFP- YY-0105B • Override Closes HFP-YV-0103 via	On Hold Pending PDSA Incorporation
			HFP-VSL-00001 Level High High • Override Closes HFP-YV-0105 via HFP- YY-0105A • Override Closes HFP-YV-0103 via HFP- YY-0103A	
	HFP-LSHH-0111 (HFP-LT-0111/ HFP-DT-0008)	SC	HFP-VSL-00001 Level High High Override Closes HFP-YV-0105 via HFP- YY-0105C	
			HFP-VSL-00001 Level High High • Override Closes HFP YV-0105 via HFP- YY-0105A • Override Closes HFP-YV-0103 via HFP- YY-0103A	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	Safety DIW Isolation Signal	SC	HFP-RK.-00016 Safety DIW Isolation Signal • Override Closes HFP-YV-0929 • Override Closes	On Hold Pending PDSA Incorporation
	HFP-FSLL-0910	SC	HFP-RK.-00016 Idle Sparge Flow Low Low Override Opens HFP-YV-0932	
	HFP-FSLL-0911	SC	HFP-RK.-00016 Idle Sparge Flow Low Low Override Opens HFP-YV-0931	
HFP-PMP-00005A/B (Melter 1 Feed Preparation Vessel Sample/Transfer Pumps)	HFP-FQSH-0113 AND HFP-YC-0039 POS2		HFP-PMP-00005A Totalized Flow High and HFP-YV-0039 in Transfer Alignment Auto Stops HFP-PMP-00005A	
	HFP-FQSH-0113 AND HFP-YC-0039 POS2 AND HFP-YC-0037 MAN		HFP-PMP-00005A Totalized Flow High andHFP-YV-0039 in Transfer Alignment and HFP-PMP-00005A in Manual Mode Override Stops HFP-PMP-00005A	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-PMP-00005A/B (Melter 1 Feed Preparation Vessel Sample/Transfer Pumps)	HFP-FQSH-0114 AND HFP-YC-0040 POS2		HFP-PMP-00005B Totalized Flow High and HFP-YV-0040 in Transfer Alignment Auto Stops HFP-PMP-00005B	
	HFP-FQSH-0114 AND HFP-YC-0040 POS2 AND HFP-YC-0038 MAN		HFP-PMP-00005B Totalized Flow High and HFP-YV-0040 in Transfer Alignment Override Stops HFP-PMP-00005B	
	ASX-ZSH-3202 AND HFP-ISH-0118 (HFP-IT-0118)	SS	ASX-SMPLR-00029 Off Position and HFP-PMP-00005A Running Override Stops HFP-PMP-00005A via HFP-JY-0106B	
			ASX-SMPLR-00029 Off Position and HFP-PMP-00005A Running Override Stops HFP-PMP-00005A	
	ASX-ZSH-3203 AND HFP-ISH-0119 (HFP-IT-0119)	SS	ASX-SMPLR-00029 Off Position and HFP-PMP-00005B Running Override Stops HFP-PMP-00005B via HFP-JY-0107B	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			ASX-SMPLR-00029 Off Position and HFP-PMP-00005B Running Override Stops HFP-PMP-00005B	
	ASX-LSH-3240	SC	ASX-SMPLR-00029 Sump Level High • Override Stops HFP-PMP-00005A via HFP-JY-0106A • Override Stops HFP-PMP-00005B via HFP-JY-0107A	
			ASX-SMPLR-00029 Sump Level High • Override Stops HFP-PMP-00005A • Override Stops HFP-PMP-00005B	
	HFP-YC-0011 RNG		HFP-AGT-00001 Not Running • Override Stops HFP-PMP-00005A • Override Stops HFP-PMP-00005B	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-VSL-00002 (Melter 1 Feed Vessel) HFP-RK.-00017 (HFP-VSL-00002 Sparge Rack)	HFP-LI-0048_BQ (HFP-LT-0048)		HFP-LT-0048 Bad Quality: • Override Closes HFP-YV-0022 • Override Closes HFP-YV-0024 • Override Closes HFP-YV-0039 • Override Closes HFP-YV-0040 • Stops HFP-EJCTR-00002 Sequence • Initiates Normal Feed Shutdown of HFP- PMP-00001/2 • Override Closes HFP-YV-1023 • Override Closes HFP-YV-0033 • Override Stop HFP-AGT-00002 • Override Closes PWD-YV-0021	
	HFP-LSH-0048 (HFP-LT-0048)		Switches volume calculation equations from equation f(x)1 for flanged bottom calculations to equation f(x)2 for inches to gallons conversion in the entire tank	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSHH-0048A (HFP-LT-0048)		HFP-VSL-00002 Level High High • Override Closes HFP-YV-0022 • Override Closes HFP-YV-0024 • Override Stop HFP-PMP-00005A/B • Override Closes HFP-YV-0039 • Override Closes HFP-YV-0040 • Override Closes HFP-YV-1023 • Override Closes PWD-YV-0021	
	HFP-LSLL-0048A (HFP-LT-0048)		HFP-VSL-00002 Level Low Low • Override Stops HFP-PMP-00007 • Override Stop HFP-AGT-00002 • Override Stops HFP-PMP-00001/2 • Stops HFP-EJCTR-00002 Sequence	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-TSHH-0017 (HFP-TT-0017)		HFP-VSL-00002 Temperature High High • Override Closes HFP-YV-0039 • Override Closes HFP-YV-0040 • Override Stops HFP-PMP-00005AIB	
	HFP-LSHH-0047 (HFP-LT-0047)	SC	HFP-VSL-00002 Level High High • Override Stops HFP-PMP-00005A via HFP-JY-0106A • Override Stops HFP-PMP-00005B via HFP-JY-0107A	On Hold Pending PDSA Incorporation
			HFP-VSL-00002 Level High High • Override Stops HFP-PMP-00005A • Override Stops HFP-PMP-00005B	
HFP-VSL-00002 (Melter 1 Feed Vessel) HFP-RK-00017 (HFP-VSL-00002 Sparge Rack)	HFP-LSHH-0207 (HFP-LT-0207/ HFP-DT-0013)	SC	HFP-VSL-00002 Level High High • Override Stop HFP-PMP-00005A via HFP-JY-0106B • Override Stop HFP-PMP-00005B via HFP-JY-0107B	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			HFP-VSL-00002 Level High High • Override Stop HFP-PMP-00005A • Override Stop HFP-PMP-00005B	
	Safety DIW Isolation Signal	SC	HFP-RK-00017 Safety DIW Isolation Signal • Override Closes HFP-YV-1029 • Override Closes HFP-YV-1030	On Hold Pending PDSA Incorporation
	HFP-FSLL-1010	SC	HFP-RK-00017 Idle Sparge Flow Low Low Override Opens HFP-YV-1032	
	HFP-FSLL-1011	SC	HFP-RK-00017 Idle Sparge Flow Low Low Override Opens HFP-YV-1031	
HFP-PMP-00007 (Melter 1 Feed Vessel Sampling Pump)	ASX-ZSH-3204 AND HFP-ISH-0208 (HFP-IT-0208)	SS	ASX-SMPLR-00029 Off Position and HFP-PMP-00007 Running Override Stops HFP-PMP-00007 via HFP-JY-0203B	
			Override Stops HFP-PMP-00007	
	ASX-LSH-3240	SC	ASX-SMPLR-00029 Sump Level High Override Stops HFP-PMP-00007 via HFP- JY-0203A	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			Override Stops HFP-PMP-00007	
HFP-PMP-00001/2 (Melter 1 Feed Vessel ADS Pumps)	HFP-YC-0018 RNG		HFP-AGT-00002 Not Running Initiates Normal Feed Shut Down ofHFP-PMP-00001/2	
	HOP-YC-0214 CLSD AND HOP-YC-0227 CLSD		HOP-HEME-00001A/B Discharge Valves Both Closed Initiates Normal Feed Shut Down ofHFP-PMP-00001/2	
	HOP-PDSHH-0222Z (HOP-PDT-0222/ HOP-PDT-0235) OR HOP-PDSHH-0223Z		HOP-HEPA-00001A/2A or HOP-HEPA-00001B/2B Pressure Differential High High Initiates Normal Feed Shut Down of HFP-PMP-00001/2	
HFP-PMP-0000112 (Melter 1 Feed Vessel ADS Pumps)	HOP-TSHH-0285Z (HOP-TT-0285/ HOP-TT-0288) OR HOP-TSHH-0284Z (HOP-TT-		HOP-HTR-00002A or HOP-HEPA-00001B Pressure Differential High High Initiates Normal Feed Shut Down ofHFP- PMP-00001/2	On Hold Pending Creation of PPJ Logic Diagrams for the HLW-HOP System

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HOP-LSHH/LSLL - 0130A (HOP-LT-0118/ HOP-LT-0130)		HOP-SCB-00001 Level High High I Low Low Initiates Normal Feed Shut Down of HFP-PMP-00001/2	
	HOP-LSHH-0110A (HOP-LT-0110/ HOP-LT-0123)		HOP-VSL-00903 Level High High Initiates Normal Feed Shut Down of HFP-PMP-00001/2	
	HOP-ADSHH-0807Z (HOP-AT-0807/ HOP-AT-0826)		HOP-ADBR-00001A COx Differential High High Initiates Normal Feed Shut Down ofHFP-PMP-00001/2	
	HOP-ASH-0808A (HOP-AT-0808)		HOP-ADBR-00001A/B Hg Hourly Average High Initiates Normal Feed Shut Down of HFP-PMP-00001/2	
	HMP Melter Plemum Pressure High High		Melter 1 Plenum Pressure High High Initiates Normal Feed Shut Down of HFP- PMP-00001/2	On Hold Pending Enhancement of HLW-HMP System

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-AGT-00001 (Melter 1 Feed Preparation Vessel Agitator)	HFP-SSLL-0062 (HFP-ST-0062/ HFP-JT-0706)	SC	HFP-AGT-00001 Speed/Power Low Low • Override Closes HFP-YV-0105 via HFP- YY-0105B • Override Closes HFP-YV-0103 via HFP- YY-0103B • Override Opens HFP-YV-0903 via HFP- YY-0903	
			HFP-AGT-00001 Speed/Power Low Low • Override Closes HFP-YV-0105 via HFP- YY-0105A • Override Closes HFP-YV-0103 via HFP- YY-0103A	
HFP-AGT-00001 (Melter 1 Feed Preparation Vessel Agitator)	HFP-SSLL-0701 (HFP-ST-07011 HFP-JT-0707)	SC	HFP-AGT-00001 Speed/Power Low Low • Override Closes HFP-YV-0105 via HFP- YY-0105C • Override Closes HFP-YV-0103 via HFP- YY-0103C • Override Opens HFP-YV-0904 via HFP- YY-0904	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			HFP-AGT-00001 Speed/Power Low Low • Override Closes HFP-YV-0105 via HFP- YY-0105A • Override Closes HFP-YV-0103 via HFP- YY-0103A	
HFP-AGT-00002 (Melter 1 Feed Vessel Agitator)	HFP-SSLL-0063 (HFP-ST-0063/ HFP-JT-0806)	SC	HFP-AGT-00002 Speed/Power Low Low Override Opens HFP-YV-1003 via HFP- YY-1003	
	HFP-SSLL-0801 (HFP-ST-08011 HFP-JT-0807)	SC	HFP-AGT-00002 Speed/Power Low Low Override Opens HFP-YV-1004 via HFP- YY-1004	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-LI-2051_BQ (HFP-LT-2051)		HFP-LT-2051 Bad Quality: • Override Closes HFP-YV-2002 • Override Closes HFP-YV-2003 • Override Closes HFP-YV-2102 • Override Closes HFP-YV-2923 • Override Closes PWD-YV-0093 • Stops HFP-EJCTR-00004 Sequence • Override Stops HFP-AGT-00004 • Override Stops HFP-PMP-00018A/B	
	HFP-LSH-2051 (HFP-LT-2051)		Switches volume calculation equations from equation f(x)l for flanged bottom calculations to equation f(x)2 for inches to gallons conversion in the entire tank	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSHH-2051A (HFP-LT-2051)		HFP-VSL-00005 Level High High • Override Closes HFP-YV-2105 via HFP- YY-2105A • Override Closes HFP-YV-2002 • Override Closes HFP-YV-2003 • Override Closes HFP-YV-2102 • Override Closes HFP-YV-2103 via HFP- YY-2103A • Override Closes HFP-YV-2923 • Override Closes PWD-YV-0093	
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-LSH-2051B (HFP-LT-2051)		HFP-VSL-00005 Transfer Volume High: • Override Closes HFP-YV-2103 • Override Stops HLP-PMP-00019A	
	HFP-LSLL-2051A (HFP-LT-2051)		HFP-VSL-00005 Level Low Low: • Stops HFP-EJCTR-00004 Sequence • Override Stops HFP-AGT-00004 • Override Stops HFP-PMP-00018A/B	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-TSHH-2010 (HFP-TT-2010)		HFP-VSL-00005 Temperature High High Override Closes HFP-YV-2103	
	HFP-YC-2105A CLSD		HFP-VSL-00005 Glass Former Addition Valve Not Closed Override Closes HFP- YV-2103	
	HFP-YC-2103A CLSD		HFP-VSL-00005 Pretreatment Isolation Valve Not Closed Override Closes HFP- YV-2105	
	HFP-PSHH-2052 (HFP-PT-2052)	SS	HFP-VSL-00005 Pressure High High Override Closes HFP-YV-2105 via HFP- YY-2105B	
			HFP-VSL-00005 Pressure High High Override Closes HFP-YV-2105 via HFP- YY-2105A	
	HFP-LSHH-0050 (HFP-LT-2050)	SC	HFP-VSL-00005 Level High High • Override Closes HFP-YV-2105 via HFP- YY-2105B • Override Closes HFP-YV-2103 via HFP- YY-2103B	On Hold Pending PDSA Incorporation

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			HFP-VSL-00005 Level High High • Override Closes HFP-YV-2105 via HFP- YY-2.105A • Override Closes HFP-YV-2103 via HFP- YY-2103A	
	HFP-LSHH-2111 (HFP-LT-21111 HFP-DT-2008)	SC	HFP-VSL-00005 Level High High Override Closes HFP-YV-2105 via HFP- YY-2105C	
			HFP-VSL-00005 Level High High • Override Closes HFP-YV-2105 via HFP- YY-2105A • Override Closes HFP-YV-2103 via HFP- YY-2103A	
	Safety DIW Isolation Signal	SC	HFP-RK.-00018 Safety DIW Isolation Signal • Override Closes HFP-YV-2929 • Override Closes HFP-YV-2930	On Hold Pending PDSA Incorporation
HFP-VSL-00005 (Melter 2 Feed Preparation Vessel)	HFP-FSLL-2910	SC	HFP-RK-00018 Idle Sparge Flow Low Low Override Opens HFP-YV-2932	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-FSLL-2911	SC	HFP-RK-00018 Idle Sparge Flow Low Low Override Opens HFP-YV-2931	
HFP-PMP-00018AIB (Melter 2 Feed Preparation Vessel Sample/Transfer Pumps)	HFP-FQSH-2113 AND HFP-YC-2039 POS2		HFP-PMP-00018A Totalized Flow High and HFP-YV-2039 in Transfer Alignment Auto Stops HFP-PMP-00018A	
	HFP-FQSH-2113 AND HFP-YC-2039 POS2 AND HFP-YC-2037 MAN		HFP-PMP-00018A Totalized Flow High and HFP-YV-2039 in Transfer Alignment Auto Stops HFP-PMP-00018A Override Stops HFP-PMP-00018A if Pump is in Manual Mode	
	HFP-FQSH-2114 AND HFP-YC-2039 POS2		HFP-PMP-00018B Totalized Flow High and HFP-YV-2040 in Transfer Alignment Auto Stops HFP-PMP-00018B	
	HFP-FQSH-2114 AND HFP-YC-2039 POS2 AND HFP-YC-2038 MAN		HFP-PMP-00018B Totalized Flow High and HFP-YV-2040 in Transfer Alignment Override Stops HFP-PMP-00018B if Pump is in Manual Mode	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	ASX-ZSH-3302 AND HFP-ISH-2118 (HFP-IT-2118)	SS	ASX-SMPLR-00042 Off Position and HFP-PMP-00018A Running Override Stops HFP-PMP-00018A via HFP-JY- 2106A	
			ASX-SMPLR-00042 Off Position and HFP-PMP-00018A Running Override Stops HFP-PMP-00018A	
	ASX-ZSH-3303 AND HFP-ISH-2119 (HFP-IT-2119)	SS	ASX-SMPLR-00042 Off Position and HFP-PMP-00018B Running Override Stops HFP-PMP-00018B HFP-JY-2107A	
			ASX-SMPLR-00042 Off Position and HFP-PMP-00018B Running Override Stops HFP-PMP-00018B	
HFP-PMP-00018A/B (Melter 2 Feed Preparation Vessel Sample/Transfer Pumps)	ASX-LSH-3340	SC	ASX-SMPLR-00042 Sump Level High • Override Stops HFP-PMP-00018A via HFP-JY-2106A • Override Stops HFP-PMP-00018B via HFP-JY-2107A	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			ASX-SMPLR-00042 Sump Level High • Override Stops HFP-PMP-00018A • Override Stops HFP-PMP-00018B	
	HFP-YC-2011 RNG		HFP-AGT-00004 Not Running • Override Stops HFP-PMP-00018A • Override Stops HFP-PMP-00018B	
HFP-VSL-00006 (Melter 2 Feed Vessel)	HFP-LI-2048_BQ (HFP-LT-2048)		HFP-LT-2048 Bad Quality: • Override Closes HFP-YV-2022 • Override Closes HFP-YV-2024 • Override Closes HFP-YV-2039 • Override Closes HFP-YV-2040 • Override Stops HFP-AGT-00005 • Override Closes HFP-YV-3023 • Initiates Normal Feed Shutdown of HFP- PMP-00003/4 • Stops HFP-EJCTR-00005 Sequence • Override Closes PWD-YV-0093	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSH-2048 (HFP-LT-2048)		Switches volume calculation equations from equation f(x)1 for flanged bottom calculations to equation f(x)2 for inches to gallons conversion in the entire tank	
	HFP-LSHH-2048A (HFP-LT-2048)		HFP-VSL-00006 Level High High • Override Closes HFP-YV-2022 • Override Closes HFP-YV-2024 • Override Stop HFP-PMP-00018A/B • Override Closes HFP-YV-2039 • Override Closes HFP-YV-2040 • Override Closes HFP-YV-3023 • Override Closes PWD-YV-0093	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-LSLL-2048A (HFP-LT-2048)		HFP-VSL-00006 Level Low Low • Override Stops HFP-PMP-00017 • Override Stops HFP-AGT-00005 • Initiates Normal Feed Shutdown of HFP- PMP-00003/4 • Stops HFP-EJCTR-00005 Sequence	
HFP-VSL-00006 (Melter 2 Feed Vessel)	HFP-TSHH-2017 (HFP-TT-2017)		HFP-VSL-00006 Temperature High High • Override Closes HFP-YV-2039 • Override Closes HFP-YV-2040 • Override Stop HFP-PMP-00018A/B	
	HFP-LSHH-2047 (HFP-LT-2047)	SC	HFP-VSL-00006 Level High High • Override Stop HFP-PMP-00018A via HFP-JY-2106A • Override Stop HFP-PMP-00018B via HFP-JY-2107A	On Hold Pending PDSA Incorporation

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			HFP-VSL-00006 Level High High • Override Stop HFP-PMP-00018A • Override Stop HFP-PMP-00018B	
	HFP-LSHH-2207 (HFP-LT-2207/ HFP-DT-2013)	SC	HFP-VSL-00006 Level High High • Override Stop HFP-PMP-00018A via HFP-JY-2106B • Override Stop HFP-PMP-00018B via HFP-JY-2107B	
			HFP-VSL-00006 Level High High • Override Stop HFP-PMP-00018A • Override Stop HFP-PMP-00018B	
	Safety DIW Isolation Signal	SC	HFP-RK.-00019 Safety DIW Isolation Signal • Override Closes HFP-YV-3029 • Override Closes HFP-YV-3030	On Hold Pending PDSA Incorporation
	HFP-FSLL-3010	SC	HFP-RK-00019 Idle Sparge Flow Low Low Override O_pens HFP-YV-3032	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-FSLL-3011	SC	HFP-RK.-00019 Idle Sparge Flow Low Low Override Opens HFP-YV-3031	
HFP-PMP-00017 (Melter 2 Feed Vessel Sampling Pump)	ASX-ZSH-3304 AND HFP-ISH-2208 (HFP-IT-2208)	SS	ASX-SMPLR-00042 Off Position and HFP-PMP-00017 Running Override Stops HFP-PMP-00017 via HFP-JY-2203A	
			ASX-SMPLR-00042 Off Position and HFP-PMP-00017 Running Override Stops HFP-PMP-00017	
	ASX-LSH-3340	SC	ASX-SMPLR-00042 Sump Level High Override Stops HFP-PMP-00017 via HFP- JY-2203A	
			ASX-SMPLR-00042 Sump Level High Override Stops HFP-PMP-00017	
HFP-PMP-00003/4 (Melter 2 Feed Vessel ADS Pumps)	HFP-YC-2018 RNG		HFP-AGT-00005 Not Running Initiates Normal Feed Shut Down ofHFP-PMP-00003/4	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
HFP-PMP-00003/4 (Melter 2 Feed Vessel ADS Pumps)	HOP-YC-2214 CLSD AND HOP-YC-2227 CLSD		HOP-HEME-00002B Discharge Valves Both Closed Initiates Normal Feed Shut Down ofHFP-PMP-00003/4	
	HOP-PDSHH-2222Z (HOP-PDT-2222/ HOP-PDT-2235) OR HOP-PDSHH-		HOP-HEPA-00001A/2A or HOP-HEPA-00001B/2B Pressure Differential High High Initiates Normal Feed Shut Down of HFP-PMP-00003/4	
	HOP-TSHH-0285Z (HOP-TT-2285/ HOP-TT-2288) OR HOP-TSHH-2284Z (HOP-TT-		HOP-HTR-00002A or HOP-HEPA-OOOOlB Pressure Differential High High Initiates Normal Feed Shut Down of HFP- PMP-00003/4	On Hold Pending Creation of PPJ Logic Diagrams for the HLW-HOP System
	HOP-LSHH/LSLL - 2130A (HOP-LT-2118/ HOP-LT-2130)		HOP-SCB-00001 Level High High I Low Low Initiates Normal Feed Shut Down of HFP-PMP-00003/4	
	HOP-LSHH-2110A (HOP-LT-2110/ HOP-LT-2123)		HOP-VSL-00903 Level High High Initiates Normal Feed Shut Down ofHFP-PMP-00003/4	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HOP-ADSHH-2807Z (HOP-AT-2807/ HOP-AT-2826)		HOP-ADBR-OOOOlA COx Differential High High Initiates Normal Feed Shut Down ofHFP-PMP-00003/4	
	HOP-ASH-2808A (HOP-AT-2808)		HOP-ADBR-OOOOlNB Hg Hourly Average High Initiates Normal Feed Shut Down ofHFP-PMP-00003/4	
	HMPMelter Plemum Pressure High High		Melter 1 Plenum Pressure High High Initiates Normal Feed Shut Down of HFP- PMP-00003/4	On Hold Pending Enhancement of HLW-HMP System
HFP-AGT-00004 (Melter 2 Feed Preparation Vessel Agitator)	HFP-SSLL-2062 (HFP-ST-2062/ HFP-JT-2706)	SC	HFP-AGT-00004 Speed/Power Low Low • Override Closes HFP-YV-2105 via HFP- YY-2105B • Override Closes HFP-YV-2103 via HFP- YY-2103B • Override Opens HFP-YV-2903 via HFP- YY-2903	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
			HFP-AGT-00004 Speed/Power Low Low • Override Closes HFP-YV-2105 via HFP- YY-2105A • Override Closes HFP-YV-2103 via HFP- YY-2103A	
	HFP-SSLL-2701 (HFP-ST-27011 HFP-JT-2707)	SC	HFP-AGT-00004 Speed/Power Low Low • Override Closes HFP-YV-2105 via HFP- YY-2105C • Override Closes HFP-YV-2103 via HFP- YY-2103C • Override Opens HFP-YV-2904 via HFP- YY-2904	
			HFP-AGT-00004 Speed/Power Low Low • Override Closes HFP-YV-2105 via HFP- YY-2105A • Override Closes HFP-YV-2103 via HFP- YY-2103A	
HFP-AGT-00005 (Melter 2 Feed Vessel Agitator)	HFP-SSLL-2063 (HFP-ST-2063/ HFP-JT-2801)	SC	HFP-AGT-00005 Speed/Power Low Low Override Opens HFP-YV-3003	

Table 4–4 Trips and Interlocks for the HLW HFP System

Trips and Interlocks for HLW HFP System				
Equipment No.	**Instrument No.**	**Properties**	**Function**	**Remarks**
	HFP-SSLL-2801 (HFP-ST-2801/ HFP-JT-2807)	SC	HFP-AGT-00005 Speed/Power Low Low Override Opens HFP-YV-3004	

4.1.6.6 Complex Control Schemes

4.1.6.6.1 General ICN Control Strategy for Pump Priming Logic

Pump priming is used by the Operator to assist in the starting of several vertical pumps within the HLW HFP system. The control loop numbers for the priming valve/pumps/handswitch can be substituted as shown in the table below for the priming logic of alternate pumps.

Table 4–5 Pump Priming Logic

PUMP	PRIMING VALVE	HANDSWITCH
HFP-PMP-00005A	HFP-YV-0002	HFP-HS-0115
HFP-PMP-00005B	HFP-YV-0003	HFP-HS-0116
HFP-PMP-00007	HFP-YV-0022	HFP-HS-0117
HFP-PMP-00018A	HFP-YV-2002	HFP-HS-2115
HFP-PMP-00018B	HFP-YV-2003	HFP-HS-2116
HFP-PMP-00017	HFP-YV-2022	HFP-HS-2117

The Operator places the hand switches for the following valves/pumps in Auto

- HFP-YV-0002 (HFP-PMP-00005A Priming Valve)
- HFP-PMP-00005A

The Operator starts the sequence by using hand switch HFP-HS-0115 to priming sequence, the sequence progresses as follows:

- HFP-YV-0002 opens
- HFP-PMP-00005A starts after a short delay
- HFP-YV-0002 closes after a short delay

The priming sequence is terminated by the priming valve closure upon starting of HFP-PMP-00005A or time elapse causing valve HFP-YV-0002 to Auto Close. If HFP-YV-0002 is in Manual Mode, then HFP-YV-0002 Override Closed upon sequence completion.

4.1.6.6.2 General ICN Control Strategy for HFP-EJCTR-00001/2

HFP-EJCTR-00001/2 are used to transfer liquid from HFP-VSL-00001/2 to RLD-VSL-00008. Listed below is the step by step operation needed to perform a transfer.

The Operator places the hand switches for the following valves in Auto

- HPS-YV-3127 (HOP-RK-00047 steam valve)
- ISA-YV-3066 (HOP-RK-00047 Air valve)
- HFP-YV-0049 (HFP-EJCTR-00001)
- HFP-YV-0033 (HFP-EJCTR-00002)

The Operator starts the transfer via HFP-EJCTR-00001/00002 using the sequence hand switches HFP-HS-0049A/0033A. The valves sequence as follows:

- ISA-YV-3066 Opens
- HFP-YV-0049/0033 Opens
- ISA-TV-3066 Closes
- HPS-YV-3127 Opens

The transfer is terminated by Operator action using the sequence hand switches or by process conditions. The valves sequence as follows.

- HPS-YV-3127 Closes
- ISA-YV-3066 Opens
- HFP-YV-0049/0033 Closes
- ISA-YV-3066 Closes

4.1.6.6.3 General ICN Control Strategy for HFP-EJCTR-00004/5

HFP-EJCTR-00004/5 are used to transfer liquid from HFP-VSL-00005/6 to RLD-VSL-00008. Listed below is the step by step operation needed to perform a transfer.

The Operator places the hand switches for the following valves in Auto

- HPS-YV-3135 (HOP-RK-0004 steam valve)
- ISA-YV-3062 (HOP-RK-0004 Air valve)
- HFP-YV-2049 (HFP-EJCTR-00003)
- HFP-YV-2033 (HFP-EJCTR-00004)

The Operator starts the transfer via HFP-EJCTR-00003/00004 using the sequence hand switches HFP-HS-2049A/2033A. The valves sequence as follows:

- ISA-YV-3062 Opens
- HFP-YV-2049/2033 Opens
- ISA-TV-3062 Closes
- HPS-YV-3135 Opens

The transfer is terminated by Operator action using the sequence hand switches or by process conditions. The valves sequence as follows.

- HPS-YV-3135 Closes
- ISA-YV-3062 Opens
- HFP-YV-2049/2033 Closes
- ISA-YV-3062 Closes

4.2 Operations

Reserved

4.3 Supplemental Information

Reserved

5 Sources, Bases, and Other References

5.1 Source / Basis References

Document Number	Rev	Title	Text Reference
24590-WTP-DB-ENG-01-001	3	Basis of Design	BOD
24590-HLW-PL-RT-07-0001	3	IHLW Waste Form Compliance Plan for the Hanford Tank Waste Treatment and Immobilization Plant	IHLW Waste Form Compliance Plan for WTP
24590-WTP-RPT-OP-01-001	6	Operations Requirements Document	ORD
24590-WTP-PSAR-ESH-01-002-04	6	Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information	PDSA - HLW Facility
24590-WTP-PSAR-ESH-01-002-02	6	Preliminary Documented Safety Analysis to Support Construction Authorization; PT Facility Specific Information	PDSA - PT Facility
24590-WTP-SRD-ESH-01-001-02	7F	Safety Requirements Document, Volume II	SRD
DE-AC27-01RV14136	N/A	DOE/BNI WTP Contract Mod No. 304, Section C - Statement of Work	WTP Contract
WA7890008967, Part 3	N/A	Dangerous Waste Portion of RCRA Permit	DWP

5.2 Other References

Document Number	Rev	Title
24590-WTP-Z0C-W13T-00010	0F	Contact Dose Rates to Equipment from Beta and Gamma Emitters
24590-WTP-J0-50-00012	2	Controls & Instrumentation In-line Flow Devices Straight Run Requirements
24590-HLW-TB-ENG-13-0002	0	Engineering Design Decision for HLW HFP
24590-HLW-WIQP-MS-09-0001	1A	HLW HFP Feed Preparation Vessels
24590-WTP-3DP-G04B-00046	32	Engineering Drawings
24590-WTP-3PS-M000-T0001	1	Engineering Specification for Air Displacement Slurry Pumps
24590-HLW-3PS-HFP-T0003	0	Engineering Specification for High Level Waste Melter Feed System Demisters, Air Ejectors and Overflow Flapper Valves
24590-WTP-3PS-P000-T0001	6	Engineering Specification for Piping Material Classes General Description and Summary
24590-WTP-3PS-JQ00-T0005	1	Engineering Specification for Management of Supplier Safety Software
24590-WTP-3PS-JQ00-T0004	1	Engineering Specification for Management of Supplier Software
24590-WTP-3PS-MACS-T0003	4	Engineering Specification for Mechanical Agitators

Document Number	Rev	Title
24590-WTP-3PS-MPC0-T0009	2	Engineering Specification for Vessel-Mounted Vertical Transfer Pumps - WTP HLW Facility
24590-101-TSA-W000-0004-172-00001	0A	Final Report: Technical Basis for HLW Vitrification Stream Physical and Rheological Property Bounding Conditions
24590-HLW-M6N-ASX-00008	N/A	General Instrumentation Revision to HLW ASX System P&ID (ASX-SMPLR-00029)
24590-HLW-M6N-ASX-00010	N/A	General Instrumentation Revision to HLW ASX System P&ID (ASX-SMPLR-00042)
24590-HLW-MFD-HFP-00003	5	Mechanical Systems Data Sheet: Mechanical Agitator
24590-HLW-MFD-HFP-00013	1	Mechanical Systems Data Sheet: Mechanical Agitator
24590-HLW-MPD-HFP-00007	5	Mechanical Systems Data Sheet: Vertical Centrifugal Pump
24590-HLW-M6C-HFP-00002	D	HFP-EJCTR-00001, -00002, -00004 and -00005 Steam Ejector Sizing Calculation
24590-HLW-M6C-HFP-00013	0C	Air Sparging Line Sizing Calculation
24590-HLW-N1D-HFP-00002	0	HFP-PMP-00007 and HFP-PMP-00017 HLW - Melter 1 and 2 Feed Vessel Sample - Recirc Pump
24590-HLW-N1D-HFP-00003	5	HFP-VSL-00001 and HFP-VSL-00005 HLW - HLW Melter 1 and 2 Feed Preparation Vessel
24590-HLW-N1D-HFP-00004	5	HFP-VSL-00002 and HFP-VSL-00006 HLW - Melter 1 and 2 Feed Vessel
24590-HLW-ES-PR-04-0001	1	HLW Melter Feed and Feed Preparation Vessel Utilization and Time Cycle Evaluation
24590-HLW-RPT-ENS-12-002	0	HLW Preliminary Post Accident Monitoring Report
24590-HLW-TB-ENG-13-0001	1	Engineering Design Decision for HLW RLD
24590-HLW-U0D-W16T-00001	1	HLW Room Environment Data Sheet
24590-HLW-WIQP-MS-09-0002	0A	WAI Item Qualification Plan for HLW Melter Feed Preparation Vessel Agitators
24590-HLW-WSF-ENG-07-005	4	WAI Screening of HLW Glass Chemistry Processing Activities
24590-PTF-MPC-HLP-00016	0B	Pump and Line Sizing Calculation for Pumps HLP-PMP-000019A/B
24590-WTP-M0C-50-00004	0E	Wear Allowance for WTP Waste Slurry Systems
24590-WTP-M0E-50-00011	N/A	Calculation of Wear Rates for Glass Formers at Velocities and Usage Factors
24590-WTP-GPG-M-0058	0A	Minimum Flow Velocity for Slurry Lines
CCN 199857	N/A	Modulating Control Valve Straight Run Guidelines
DOE-STD-1020-94	N/A	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
24590-WTP-M6-50-00008	3	P&ID Symbols and Legend (Sheet 8 of 8)
24590-WTP-DB-PET-09-001	1	Process Inputs Basis of Design (PIBOD)
24590-WTP-GPG-ENG-0159	4	Single Failure Analysis Process for Mechanical, HVAC and Control Systems
24590-WTP-GPP-SQP-208	5	Plant Software Life Cycle Management
24590-WTP-GPG-M-013	2A	Plant Wash System Design
24590-101-TSA-W000-0009-195-00003	0A	Pretreated Waste and Melter Feed Composition Variability Testing using HLW Simulants

Document Number	Rev	Title
24590-HLW-MVC-HFP-00001	1	Process Information for HFP Vessels (HFP-VSL-00001, HFP-VSL-00002, HFP-VSL-00005, and HFP-VSL-00006)
24590-WTP-DB-PET-09-001	1	Process Inputs Basis of Design
24590-WTP-GPG-M-027	5	Recommended Slopes for Piping Systems
CCN 241253	N/A	Response to Defense Nuclear Facilities Safety Board (DNFSB) Staff Issue Report Regarding Plugging of Process Lines, Pretreatment Facility, Waste Treatment Plant, Hanford Site
24590-WTP-M4C-V11T-00011	0C	Revised Calculation of Hydrogen Generation Rates and Times to Lower Flammability Limit for WTP
24590-HLW-ES-ENG-13-003	0	Risk Reduction Study for the High Level Waste (HLW) Facility: Failure Modes, Effects, and Criticality Analysis (FMECA), In-Service Inspection (ISI), and Plugging
24590-HLW-PL-ENS-13-0001	0A	Safety Design Strategy for the High-Level Waste Facility
24590-WTP-GPG-J-015	7	Safety Instrumented System Implementation
24590-WTP-3DP-G04B-00093	7	System and Facility Design Descriptions
24590-WTP-GPG-ENG-0161	0	Technical Requirements Management
24590-WTP-GPG-ENG-0159	4	Single Failure Analysis Process for Mechanical, HVAC and control Systems
CCN 200377	N/A	WAI Screening of HFP Sample Loop Flow Meter
24590-WTP-PL-RACT-RT-0001	0	WTP Remotability Verification Plan
42 USC 6901	N/A	Resource Conservation and Recovery Act of 1976
ASTM A312	N/A	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A240	N/A	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

5.3 Design References

Document Number	Title
Process Flow Diagrams	
24590-HLW-M5-V17T-00001	Process Flow Diagram HLW Receipt & Feed Preparation (System HCP, GFR, & HFP)
P&IDs	
24590-PTF-M6-PWD-00057	PTF - P&ID Plant Wash & Disposal System Underground Transfer Lines
24590-HLW-M6-HCP-00001001	P&ID - HLW Concentrate Receipt Process System Melter 1 Transfer Piping
24590-HLW-M6-HCP-00002001	P&ID - HLW Concentrate Receipt Process System Melter 2 Transfer Piping
24590-HLW-M6-HFP-00001001	P&ID - HLW - HLW Melter Feed Process System Melter Feed Preparation HFP-VSL-00001
24590-HLW-M6-HFP-00001002	P&ID - HLW - HLW Melter Feed Process Sys Process System Sample/Transfer Pumps HFP-PMP-00005A/B
24590-HLW-M6-HFP-00001003	P&ID - HLW - HLW Melter Feed Process System Instrumentation / Vent HFP-VSL-00001
24590-HLW-M6-HFP-00001004	P&ID - HLW - HLW Melter Feed Process System Cooling and Utilities HFP-VSL-00001

Document Number	Title
24590-HLW-M6-HFP-00002001	P&ID - HLW HLW Melter Feed Process System Melter Feed Vessel HFP-VSL-00002
24590-HLW-M6-HFP-00002002	P&ID - HLW HLW Melter Feed Process System Instrumentation/Vent HFP-VSL-00002
24590-HLW-M6-HFP-00002003	P&ID - HLW HLW Melter Feed Process System Cooling and Utilities HFP-VSL-00002
24590-HLW-M6-HFP-00005001	P&ID - HLW - HLW Melter Feed Process System Ads Pump Controls HFP-PMP-00001
24590-HLW-M6-HFP-00005002	P&ID - HLW - HLW Melter Feed Process System Ads Pump Controls HFP-PMP-00002
24590-HLW-M6-HFP-00007001	P&ID - HLW - HLW Melter Feed Process System Agitation and Sparging HFP-VSL-00001
24590-HLW-M6-HFP-00008001	P&ID - HLW - HLW Melter Feed Process System Agitation and Sparging HFP-VSL-00002
24590-HLW-M6-HFP-00009001	P&ID - HLW - HLW Melter Feed Process System Sparge Rack Utility Supplies
24590-HLW-M6-HFP-00009002	P&ID - HLW - HLW Melter Feed Process System Rack Controls HFP-Rk-00016
24590-HLW-M6-HFP-00009003	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00016
24590-HLW-M6-HFP-00009004	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00016
24590-HLW-M6-HFP-00010001	P&ID - HLW - HLW Melter Feed Process System Sparge Rack Utility SUPPLIES
24590-HLW-M6-HFP-00010002	P&ID - HLW - HLW Melter Feed Process System Rack Controls HFP-RK-00017
24590-HLW-M6-HFP-00010003	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00017
24590-HLW-M6-HFP-00010004	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00017
24590-HLW-M6-HFP-20001001	P&ID - HLW - HLW Melter Feed Process System Helter Feed Preparation HFP-VSL-00005
24590-HLW-M6-HFP-20001002	P&ID - HLW - HLW Melter Feed Process System Sample/Transfer Pumps HFP-PMP-00018A/B
24590-HLW-M6-HFP-20001003	P&ID - HLW - HLW Melter Feed Process System Instrumentation / Vent HFP-VSL-00005
24590-HLW-M6-HFP-20001004	P&ID - HLW - HLW Melter Feed Process System Cooling and Utilities HFP-VSL-00005
24590-HLW-M6-HFP-20002001	P&ID - HLW HLW Melter Feed Process System Melter Feed Vessel HFP-VSL-00006
24590-HLW-M6-HFP-20002002	P&ID - HLW HLW Melter Feed Process System Instrumentation/Vent HFP-VSL-00006
24590-HLW-M6-HFP-20002003	P&ID - HLW HLW Melter FEED PROCESS SYSTEM COOLING AND UTILITIES HFP-VSL-00006
24590-HLW-M6-HFP-20005001	P&ID - HLW - HLW Melter FEED PROCESS SYSTEM ADS PUMP CONTROLS HFP-PMP-00014
24590-HLW-M6-HFP-20005002	P&ID - HLW - HLW Melter FEED PROCESS SYSTEM ADS PUMP CONTROLS HFP-PMP-00015
24590-HLW-M6-HFP-20007001	P&ID - HLW - HLW Melter Feed Process System Agitation and Sparging HFP-VSL-00005
24590-HLW-M6-HFP-20008001	P&ID - HLW - HLW Melter Feed Process System Agitation and Sparging HFP-VSL-00006
24590-HLW-M6-HFP-20009001	P&ID - HLW - HLW Melter Feed Process System Sparge Rack Utility SUPPLIES
24590-HLW-M6-HFP-20009002	P&ID - HLW - HLW Melter Feed Process System Rack Controls HFP-RK-00018
24590-HLW-M6-HFP-20009003	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00018

Document Number	Title
24590-HLW-M6-HFP-20009004	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00018
24590-HLW-M6-HFP-20010001	P&ID - HLW - HLW Melter Feed Process System Sparge Rack Utility SUPPLIES
24590-HLW-M6-HFP-20010002	P&ID - HLW - HLW Melter Feed Process System Rack Controls HFP-RK-00019
24590-HLW-M6-HFP-20010003	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-00019
24590-HLW-M6-HFP-20010004	P&ID - HLW - HLW Melter Feed Process System Distribution Header HFP-RK-000019
24590-HLW-M6-HMP-00001001	P&ID - HLW HLW Melter Process System Melter 1 Feed and Agitation
24590-HLW-M6-HMP-20001001	P&ID - HLW HLW Melter Process System Melter 2 Feed and Agitation
24590-HLW-M6-HMP-00013002	*P&ID - HLW HLW Melter Process System Melter 1 Pressure, Density and Level Detection HMP-RK-00021*
24590-HLW-M6-HMP-20013002	*P&ID - HLW HLW Melter Process System Melter 2 Pressure, Density and Level Detection HMP-RK-00023*
24590-HLW-M6-PWD-00006001	*P&ID - HLW Plant Wash and Disposal System Plant Wash Distribution Rack PWD-RK-00037*
24590-HLW-M6-PWD-20003001	*P&ID - HLW Plant Wash and Disposal System Plant Wash Distribution Rack PWD-RK-00044*
24590-HLW-M6-ASX-00004	P&ID - HLW Autosampling System Sample Cabinets ASX-SMPLR-00029
24590-HLW-M6-ASX-00005	P&ID - HLW Autosampling System Sample Cabinets ASX-SMPLR-00042
General Arrangement / Equipment Location Drawings	
24590-HLW-P1-P01T-00001	HLW Vitrification Building General Arrangement PLAN at EL -21'-0"
24590-HLW-P1-P01T-00002	HLW Vitrification Building General Arrangement PLAN at EL 0'-0"
24590-HLW-P1-P01T-00003	HLW Vitrification Building General Arrangement PLAN at EL 14'-0"
24590-HLW-P1-P01T-00005	HLW Vitrification Building General Arrangement Plan at EL 58'0"
24590-HLW-P1-P01T-00009	HLW Vitrification Building General Arrangement Sections D-D, E-E & F-F
24590-HLW-P1-P23T-00113	HLW Vitrification Building Equipment Location PLAN EL. 0'-0" / Area 113
24590-HLW-P1-P23T-00114	HLW Vitrification Building Equipment Location PLAN EL. 0'-0" / Area 114
24590-HLW-P1-P23T-00115	HLW Vitrification Building Equipment Location PLAN EL. 0'-0" / Area 115
24590-QL-POA-MVA0-00018-03-00002	Drawing- HLW Melter ½ Feed Preparation Vessel Assembly Drawing

Appendix A Test Objectives, Conditions, and Acceptance Criteria

NOTE: Demonstrations and Tests identified in this appendix are preliminary, pending completion of design activities. They are established to document the flowdown of verification needs established in Section 3 but are not sufficiently detailed for development of specific system and equipment test plans. They may be used for general planning only. This note is to be removed when design is sufficiently progressed to provide the details needed to establish the basis for testing and acceptance criteria. **[HOLD]**

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.4.1.1.1	SU/COM	Perform integrated system test to verify the sample/transfer pumps are capable of providing a minimum transfer rate of 44 gpm from the MFPV to the MFV. Sample/Transfer Pumps - Component Tag Numbers (CTNs): HFP-PMP-00005A, -00005B, -00018A, and -00018B. Measure the flow rate using the following flow meters for the respective HFP vessels: Sample/Transfer - Flow Meters - CTNs: HFP-FE-0113, -0114, -2113, and -2114	**(GTC)** HFP sample/transfer pumps are capable of providing a minimum flow rate of 44 gpm from the MFPV to both the MFV and ASX.		Sample/Transfer Pumps operating Simulant with a viscosity of ≥40 cP and yield stress of ≥30 Pa or an approved alternative (i.e., in a test plan) PCJ operating and monitoring transfer velocity of sample/transfer pumps
3.4.1.1.2	SU/COM	Perform integrated system test to verify the ADS pumps are capable of providing a minimum transfer rate of 2 gpm from the MFV to the melter. ADS Pumps - CTNs: HFP-PMP-00001, -00002, -000014, and -00015. No flow meters - This can be measured based on level change in the MFV.	**(GTC)** ADS pumps are capable of providing a minimum flow rate of 2 gpm from the MFV to the melter.	System is not instrumented with permanent flow meter. This can be measured based on level change in the MFV.	ADS pumps operating Simulant with a viscosity of ≥40 cP and yield stress of ≥30 Pa or an approved alternative (i.e., in a test plan) ISA operating PCJ operating and monitoring airflow of ISA to ADS pumps
3.4.1.1.3	SU/COM	Perform integrated system test to verify the sample/transfer pumps are capable of providing a minimum transfer rate of 44 gpm from the MFPV to the ASX. Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00018A, and -00018B. Measure the flow rate using the following flow meters for the respective HFP vessels: Sample/Transfer - Flow Meters - CTNs: HFP-FE-0113, -0114, -2113, and -2114	**(GTC)** HFP sample/transfer pumps are capable of providing a minimum flow rate of 44 gpm from the MFPV to the ASX.		Sample/Transfer Pumps operating Simulant with a viscosity of ≥40 cP and yield stress of ≥30 Pa or an approved alternative (i.e., in a test plan) PCJ operating and monitoring transfer velocity of sample/transfer pumps
3.4.4.1	SU/COM	Demonstrate remotability in accordance with test plans developed by the Commissioning Remote Handling work group per 24590-WTP-PL-RACT-RT-0001, *WTP Remotability Verification Plan.*	**(GTC)** Successful remote removal and re-installation of the all the HFP equipment/ components listed in the test plans.	Physical demonstration	Pre-Hot Operations HSH operating
3.4.4.3	SU/COM	Demonstrate the capability to flush the HLW concentrate transfer lines from the HLW Facility to the PT Facility, using water from the HLW Facility.	**(GTC)** System demonstrates the capability to flush the PT Facility HLW concentrate		Simulant required

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
		Perform a baseline flush test measurement without simulant, and then perform a second flush test after a simulant transfer.	transfer lines using water from the HLW Facility. Flush velocity 6-12 fps		
3.5.3.8	SU/COM	Demonstrate the steam ejectors can transfer HFP vessel washwater to the RLD (RLD-VSL-00008).	**(GTC)** The steam ejectors are capable of transferring washwater from the HFP vessels to RLD-VSL-00008.	This will be performed during the verification of requirement 3.5.4.1	See Requirement 3.5.4.1
3.6.3.1	SU/COM	Perform integrated system test to verify flushing velocity meets the acceptable range for the following sample and transfer line flushes listed below and using up to 3 line volumes of demineralized water: • **HLW Concentrate Piping between PT Facility and HLW Facility MFPV** o Flow Transmitter - CTN: PWD-FT-0401, PWD-FT-0402, DIW-FT-1310, and DIW-FT-1321 (24590-HLW-M6-HLP-00009001 and 24590-PTF-M6-DIW-00003001) • **Sample/Recirculation Piping between each HFP Vessel and the ASX** o Flow Transmitter – CTN: DIW-FT-3102 (24590-HLW-M6-DIW-00001001) • **HLW Melter Feed Piping from MFPV to MFV** o Flow Transmitter – CTN: DIW-FT-3102 (24590-HLW-M6-DIW-00001001) • **HLW Melter Feed Piping from MFV to Melter** o Flow Transmitter – CTN: DIW-FT-0034E (24590-HLW-M6-HFP-00005001) • **HLW Process Waste Transfer line between Melter Cave 1 and Melter Cave 2** o **TBD**	**(GTC)** The velocity of the transfer line flush is within the acceptable range to prevent solids from settling in the piping. 6-12 fps for slurries without glass formers and 6-10 fps for slurries with glass formers		PCJ operating and monitoring flow meters Integrated water run Simulant not required
3.6.4.1	SU/COM	Demonstrate flushing and draining capabilities during integrated system testing.	**(GTC)** System demonstrates capability of being drained and/or pumped to remove flushing liquid from equipment, components, and piping.	This will be performed during the verification of requirement 3.6.3.1	See Requirement 3.6.3.1
3.6.4.2	SUP& SU/COM	(SUP) Test fabricated valves to verify their closure rate meets the specified performance criteria for preventing water hammer. (SU/COM) Demonstrate that valve closure rates to do not produce water hammer.	(GTC) The valves closure rate meets the performance criteria. Performed by supplier. (GTC) The installed valves closure rate does not produce water hammer. Performed on installed valves.		All normal operating conditions.
3.8.3.1	SU/COM	Perform integrated system test to verify the ISA provides air purge supply to the spargers of at least 200 times the maximum HGR. **Sparger Tube - Flow Meters:** • HFP-VSL-00001 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-0912, -0913, -0914, -0915, -0916, -0917, -0918, and -0919 (HFP-RK-00016, 24590-HLW-M6-HFP-00009003/-00009004) • HFP-VSL-00002 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-1012, -1013, -1014, -1015, -1016, -1017, -1018, and -1019 (HFP-RK-00016, 24590-HLW-M6-HFP-00010003/-00010004) • HFP-VSL-00005 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-2912, -2913, -2914, -2915, -2916, -2917, -2918, and -2919 (HFP-RK-00018, 24590-HLW- M6-HFP-20009003/-20009004) • HFP-VSL-00006 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-3012, -3013, -3014, -3015, -3016, -30117, -3018, and -3019 (HFP-RK-00018, 24590-HLW- M6-HFP-20010003/-20010004)	**(TAC)** The ISA is capable of providing a minimum airflow to the spargers of at least 200 times the maximum HGR.		PCJ operating and monitoring airflow of ISA Vessel content level at normal operating level

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
		Main Header Supply to Sparger Tubes - Flow Meters: • HFP-VSL-00001 (MFPV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-0906, -0907, -0910, and -0911 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002) • HFP-VSL-00002 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-1006, -1007, -1010, and -1011 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002) • HFP-VSL-00005 (MFPV) - Sparger Main Header Flow Meters CTNs: HFP-FT-2906, -2907, -2910, and -2911 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002) • HFP-VSL-00006 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-3006, -3007, -3010, and -3011 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002)			
3.8.3.2	SU/COM	Perform integrated system test to verify the ISA provides emergency air sparging supply to the spargers at the minimum design flow rate 42 scfm/sparger tube. **Sparger Tubes - Flow Meters:** • HFP-VSL-00001 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-0912, -0913, -0914, -0915, -0916, -0917, -0918, and -0919 (HFP-RK-00016, 24590-HLW-M6-HFP-00009003/-00009004) • HFP-VSL-00002 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-1012, -1013, -1014, -1015, -1016, -1017, -1018, and -1019 (HFP-RK-00016, 24590-HLW-M6-HFP-00010003/-00010004) • HFP-VSL-00005 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-2912, -2913, -2914, -2915, -2916, -2917, -2918, and -2919 (HFP-RK-00018, 24590-HLW- M6-HFP-20009003/-20009004) • HFP-VSL-00006 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-3012, -3013, -3014, -3015, -3016, -30117, -3018, and -3019 (HFP-RK-00018, 24590-HLW- M6-HFP-20010003/-20010004) **Main Header Supply to Sparger Tubes - Flow Meters:** • HFP-VSL-00001 (MFPV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-0906, -0907, -0910, and -0911 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002) • HFP-VSL-00002 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-1006, -1007, -1010, and -1011 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002) • HFP-VSL-00005 (MFPV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-2906, -2907, -2910, and -2911 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002) • HFP-VSL-00006 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-3006, -3007, -3010, and -3011 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002)	**(TAC)** The ISA is capable of providing a minimum airflow of 42 scfm per sparge tube.		SC ISA operating PCJ/PPJ operating and monitoring airflow of ISA Vessel content level at normal operating level
3.9.3.1.1	SU/COM	Perform an integrated system demonstration to verify the DIW system provides a water supply for priming the sample/transfer pumps. Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. DIW System Supply Flow Meter - CTNs: PWD-FT-0651 and PWD-FT-2351 (24590-HLW-M6-PWD-00006001 and 24590-HLW-M6-PWD-20003001)	**(GTC)** The DIW system is capable of providing a water supply for priming the sample/transfer pumps and the pumps operate.		Sample/Transfer pumps operating Simulant Required
3.9.3.2.1	SU/COM	Perform a test to verify the ISA provides adequate force to operate the ADS pumps at the required transfer rate. ADS Pumps - CTNs: HFP-PMP-00001, -00002, -000014, and -00015.	**(GTC)** The ISA system is capable of providing an air supply for the pumps to operate at the design flow rate.	This will be performed during the verification of requirement 3.4.1.1.2	See Requirement 3.4.1.1.2
3.10.1.1.1	SU/COM	Demonstrate the capability to remotely monitor HFP vessel temperature in the facility control room. Temperature Elements - CTNs: HFP-TE-0010, -2010, -0017, and -2017	**(GTC)** The temperature elements are monitored and displayed on the PCJ.		PCJ operating and monitoring

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
					Simulate HFP vessel temperature
3.10.1.1.2	SU/COM	Demonstrate the capability to remotely monitor HFP vessel pressure in the facility control room. Pressure Indicators - CTNs: HFP-PT-0052, -2052 (**TBD** for the MFV pressure indicators)	(**GTC**) The pressure elements are monitored and displayed on the PCJ.		PCJ operating and monitoring Simulate HFP vessel pressure
3.10.1.1.4	SU/COM	Perform integrated system test to verify the radar level sensor to have an accuracy of ±2 % of full-scale for the normal operating range of the vessel level MFPVs - CTNs: HFP-VSL-00001 and -00005. MFPVs - Level Detection - CTNs: HFP-LT-0051 and -2051	(**GTC**) The vessel level volume detected is within ±2 % of full-scale of the actual volume of water added to the vessel.	Accuracy of level detection will be verified during mapping of the vessel colume versus radar level output for the MFPVs.	Integrated water run PCJ operating and monitoring HFP vessel radar level detection operating Bubblers operating Agitators off
3.10.1.2.3	SU/COM	Demonstrate the capability to remotely monitor agitator speed and power in the facility control room. Mechanical Agitator Speed Sensors - CTNs: HFP-ST-0062, HFP-ST-0063, HFP-ST-0701, HFP-ST-0801, HFP-ST-2062, HFP-ST-2063, HFP-ST-2701, and HFP-ST-2801 Mechanical Agitator Power Sensors - CTNs: HFP-JT-0706, HFP-JT-0707, HFP-JT-0806, HFP-JT-0807, HFP-JT-2706, HFP-JT-2707, HFP-JT-2806, HFP-JT-2807	(**TAC**) The PPJ is capable of remotely monitoring the agitator speed and power in the facility control room.		PPJ operating and monitoring Simulate mechanical agitator power and speed
3.10.1.3.1	SU/COM	Perform a demonstration to verify the capability to monitor the sparger airflow rates using the PCJ.	(**TAC**) The PCJ is capable of monitor the airflow rate through the spargers.	This will be performed during the verification of requirements 3.8.3.1 and 3.8.3.2	See Requirements 3.8.3.1 and 3.8.3.2
3.10.1.3.2	SU/COM	Demonstrate the capability to initiate emergency sparge airflow when the PPJ receives a signal to initiate emergency sparge mode.	(GTC) A signal sent from the PPJ initiates emergency sparging.		PPJ operating and monitoring Simulate loss of mechanical agitator power.
3.10.1.3.3	SU/COM	Verify ISA safety air control valves switch from non-Safety purge ISA to Safety ISA supply to the spargers when the flow rate drops below the (**TBD**) setpoint.	(**TAC**) PPJ is capable of switching the ISA safety air control valves from non-Safety purge ISA to Safety ISA supply to the spargers when the flow rate drops below the setpoint.	This will be performed during the verification of requirement 3.10.2.1.3	See Requirement 3.10.2.1.3
3.10.1.4.2	SU/COM	Demonstrate the capability to automatically terminate transfer from MFV to the melter when a high-high-high pressure (**TBD**) setpoint is reached in the melter plenum using the PPJ. ADS Pumps - CTNs: HFP-PMP-00001, -00002, -000014, and -00015. HMP Pressure Sensors - CTNs: HMP-PDT-0139A, -0139B, -2139A, and -2139B (24590-HLW-M6-HMP-00013002 and 24590-HLW-M6-HMP-20013002)	(**TAC**) The ADS pumps shutdown operation upon receipt of a high melter pressure signal from the PPJ.		PPJ operating and monitoring pressure in the melter ADS pumps operating Simulate high melter pressure interlock signal to shutoff the ADS pumps

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.10.2.1.1	SU/COM	Perform a test to verify the glass former feed line isolation valve closes in response to interlock signal. Mechanical Agitator Speed Sensors - CTNs: HFP-ST-0062, HFP-ST-0063, HFP-ST-0701, HFP-ST-0801, HFP-ST-2062, HFP-ST-2063, HFP-ST-2701, and HFP-ST-2801 Mechanical Agitator Power Sensors - CTNs: HFP-JT-0706, HFP-JT-0707, HFP-JT-0806, HFP-JT-0807, HFP-JT-2706, HFP-JT-2707, HFP-JT-2806, HFP-JT-2807 Glass Former Feed Isolation Valves - CTNs: HFP-YV-0105 and HFP-YV-2105 Waste Transfer Isolation Valves- CTNs: HFP-YV-0103 & HFP-YV-2103	**(TAC)** The isolation valve on the glass former feed line closes when either of the following PCJ/PPJ conditions are met: • The MFPV mechanical agitator speed or power is outside of (**TBD**) setpoint values (i.e., during emergency sparge mode) or • Glass formers are not being fed to the MFPVs and the glass former isolation valve is open (Source of not being fed signal indeterminate).		PCJ/PPJ operating and monitoring Simulate conditions via PPJ
3.10.2.1.2	SU/COM	Test the PPJ system to verify the emergency sparger mode is initiated when the mechanical agitator is unavailable (speed or power outside established (**TBD**) setpoints). Countdown timer will need to be accelerated to initiate the operation of the safety air control valves. Mechanical Agitator Speed Sensors - CTNs: HFP-ST-0062, HFP-ST-0063, HFP-ST-0701, HFP-ST-0801, HFP-ST-2062, HFP-ST-2063, HFP-ST-2701, and HFP-ST-2801 Mechanical Agitator Power Sensors - CTNs: HFP-JT-0706, HFP-JT-0707, HFP-JT-0806, HFP-JT-0807, HFP-JT-2706, HFP-JT-2707, HFP-JT-2806, HFP-JT-2807 Waste Transfer Isolation Valves- CTNs: HFP-YV-0103 & HFP-YV-2103 <u>Safety Air Control Valves:</u> CTNs: HFP-YV-0903, -0931, -0904, and -0932 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002) CTNs: HFP-YV-1003, -1031, -1004, and -1032 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002) CTNs: HFP-YV-2903, -2931, -2904, and -2932 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002) CTNs: HFP-YV-3003,-3031, -3004, and -3032 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002)	**(TAC)** The spargers switch from idle to emergency sparge mode (countdown) upon receipt of a signal from the PPJ that the agitator is unavailable based on the (**TBD**) setpoints.		PCJ/PPJ operable SC ISA operable Simulate conditions via PPJ Countdown timer operable
3.10.2.1.3	SU/COM	Test the PPJ system to verify the ISA safety air control valves switch from non-safety purge ISA to safety ISA supply to the spargers when the flow rate drops below the (**TBD**) setpoint. <u>Safety Air Control Valves:</u> CTNs: HFP-YV-0903, -0931, -0904, and -0932 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002) CTNs: HFP-YV-1003, -1031, -1004, and -1032 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002) CTNs: HFP-YV-2903, -2931, -2904, and -2932 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002) CTNs: HFP-YV-3003, -3031, -3004, and -3032 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002)	**(TAC)** PPJ is capable of switching the ISA safety air control valves from non-Safety purge ISA to Safety ISA supply to the spargers when the flow rate drops below the setpoint.		PCJ/PPJ operable Safety and non-Safety ISA operable Simulate conditions via PPJ
3.10.2.1.4	SU/COM	Demonstrate the HFP vessel air amplifiers are activated in response to a seismic shutdown signal. Air Amplifier CTNs: HFP-EJCT-00006, -00007, -00008, and -00009.	**(TAC)** The air amplifiers are automatically activated following the seismic signal activation.		PCJ/PPJ operating Simulate seismic shutdown signal SC ISA operable HOP shutdown Spargers in emergency sparge mode (full sparge flow)

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
					Ventilation in seismic safe mode
3.10.2.2.1	SU/COM	Verify the high-high liquid level feed diversion valve interlock will shut the feed diversion valve and turn off the HLP transfer pumps when MFPV content levels exceed (**TBD**) setpoint values. MFPV Feed Diversion Valves - CTNs: HFP-YV-0103 and HFP-YV-2103 HLP Transfer Pumps - CTNs: HLP-PMP-00019A and HLP-PMP-00019B	(**TAC**) The HLP transfer pumps shutdown when the PPJ detects a high-high liquid level that exceeds (**TBD**) setpoint values in the MFPV.		Simulate MFPV contents reach the high-high liquid level PCJ/PPJ operable Simulate conditions via PPJ HLP transfer pumps operable
3.10.2.2.2	SU/COM	Test the glass former feed line isolation valve position response to the interlock scenarios listed below: • HFP-VSL-00001/HFP-VSL-00005 headspace pressure, glass former feed line isolation valve interlock • HFP-VSL-00001/HFP-VSL-00005 waste level, glass former feed line isolation valve interlock • HOP pressure, glass former feed line isolation valve interlock Glass Former Feed Isolation Valves - CTNs: HFP-YV-0105 and HFP-YV-2105 HFP-VSL-00001/HFP-VSL-00005 headspace pressure - CTNs: HFP-PT-0052 and HFP-PT-2052 Waste Level - CTNs: **TBD** HOP Pressure - CTNs: **TBD** Setpoint values are **TBD** for MFPV headspace pressure, waste level, HOP pressure	(**TAC**) The glass former feed line isolation valves are capable of closing when the PPJ detects the activation of the following interlocks: • HFP-VSL-00001/ HFP-VSL-00005 headspace pressure glass former feed line isolation valve interlock • HFP-VSL-00001/ HFP-VSL-00005 waste level glass former feed line isolation valve interlock • HOP pressure glass former feed line isolation valve interlock		PCJ/PPJ operable Simulate conditions via PPJ
3.10.2.2.3	SU/COM	Perform a Test to verify the HFP vessel sample/transfer pumps shutoff upon receiving a signal from the control system in response to a high liquid-level (**TBD**) setpoint interlock in the ASX sample enclosure. Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. ASX Samplers - CTNs: ASX-SMPLR-00029 and ASX-SMPLR-00042	(**TAC**) The HFP sample/transfer pumps shutdown upon receipt of the liquid level detection signal from the PPJ.		HFP sample/transfer pumps operating PPJ operating Simulate interlock signal to shutoff the sample/transfer pumps
3.10.2.2.4	SU/COM	Perform a Test to verify the HFP vessel sample/transfer pumps cannot startup when the ASX three-way valves are positioned open to the sample line flush connection. Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. ASX three-way valves - CTNs: (YV-3202, YV-3203, YV-3204, YV-3302, YV-3303, and YV-3304) in ASX system Valve Limit Switches- CTNs: (ZSH-3202, ZSH-3203, ZSH-3204, ZSH-3302, ZSH-3303, and ZSH-3304)	(**TAC**) The HFP vessel sample/transfer pumps cannot startup when the ASX three-way valves are positioned open to the sample line flush connection		PPJ monitoring valve position Sample/transfer pumps are operable DIW system is operating Simulate permissive signal to the sample/transfer pumps
3.10.2.2.4	SU/COM	Perform a demonstration to verify the HFP vessel sample/transfer pumps terminate operation when the ASX three-way valves are positioned open to the sample line flush connection while the HFP vessel sample/transfer pumps are in operation. Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. ASX three-way valves - CTNs: (ASX-YV-3202, -3203, -3204, -3302, -3303, and -3304) in ASX system	(**TAC**) The HFP vessel sample/transfer pumps shutdown operation when the ASX three-way valves are positioned open to the sample line flush connection.		PPJ monitoring valve position Sample/transfer pumps are operating DIW system is operating Simulate interlock signal to shutoff the sample/transfer pumps

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.10.4.1	SU/COM	Demonstrate the PCJ remote control operations for all the listed HFP equipment/components on both melter lines. **The following control functions (e.g., operate valves open/close, turn motors/pumps on/off) are performed by the PCJ:** • ADS Pumps - CTNs: HFP-PMP-00001, -00002, -000014, and -00015. • Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. • HLP Transfer Pumps - CTNs: HLP-PMP-00019A and HLP-PMP-00019B • MFPV Feed Diversion Valves - CTNs: HFP-YV-0103 and HFP-YV-2103 • MFV Transfer/Sample Recirc Line - Three Way Valves – CTNs: HFP-YV-0040, -0039, -2040, and -2039 • Glass Former Feed Isolation Valves - CTNs: HFP-YV-0105 and HFR-YV-2105 • Safety Air Control Valves - CTNs: HFP-YV-0903, -0931, -0904, and -0932 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002), CTNs: HFP-YV-1003,-1031, -1004, and -1032 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002), CTNs: HFP-YV-2903, -2931, -2904, and -2932 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002), CTNs: HFP-YV-3003,-3031, -3004, and -3032 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002) • Steam Ejectors - Steam Supply Valves – HFP-YV-0049, HFP-YV-0033, HFP-YV-2033, and HFP-YV-2049 • Mechanical Agitators - HFP-AGT-00001, HFP-AGT-00002, HFP-AGT-00004, and HFP-AGT-00005 **The following monitoring functions (parameters and status) are performed by the PCJ:** Parameters (e.g., flow rate, speed, power, pressure) • HFP Vessels - Temperature Elements - CTNs: HFP-TE-0010, -2010, -0017, and -2017 • MFPVs - Pressure Indicators - CTNs: HFP-PT-0052, -2052 • MFVs - Pressure Indicators - CTNs: **TBD** • HFP Vessels - Level Detection - CTNs: HFP-LT-0050, -0051, -2050, and -2051 • Mechanical Agitator Speed Sensors - CTNs: HFP-ST-0062, HFP-ST-0063, HFP-ST-0701, HFP-ST-0801, HFP-ST-2062, HFP-ST-2063, HFP-ST-2701, and HFP-ST-2801 • Mechanical Agitator Power Sensors - CTNs: HFP-JT-0706, HFP-JT-0707, HFP-JT-0806, HFP-JT-0807, HFP-JT-2706, HFP-JT-2707, HFP-JT-2806, HFP-JT-2807 • Sample/Transfer - Flow Meters - CTNS: HFP-FE-0113, -0114, -2113, and -2114 • DIW System Supply Flow Meter - CTNs: PWD-FT-0651 and PWD-FT-2351 (24590-HLW-M6-PWD-00006001 and 24590-HLW-M6-PWD-20003001) • Sparger Tubes - Flow Meters: - HFP-VSL-00001 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-0912, -0913, -0914, -0915, -0916, -0917, -0918, and -0919 (HFP-RK-00016, 24590-HLW-M6-HFP-00009003/-00009004) - HFP-VSL-00002 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-1012, -1013, -1014, -1015, -1016, -1017, -1018, and -1019 (HFP-RK-00016, 24590-HLW-M6-HFP-00010003/-00010004) - HFP-VSL-00005 (MFPV) - Sparger Flow Meters - CTNs: HFP-FT-2912, -2913, -2914, -2915, -2916, -2917, -2918, and -2919 (HFP-RK-00018, 24590-HLW- M6-HFP-20009003/-20009004) - HFP-VSL-00006 (MFV) - Sparger Flow Meters - CTNs: HFP-FT-3012, -3013, -3014, -3015, -3016, -30117, -3018, and -3019 (HFP-RK-00018, 24590-HLW- M6-HFP-20010003/-20010004) • Main Header Supply to Sparger Tubes - Flow Meters: - HFP-VSL-00001 (MFPV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-0906, -0907, -0910, and -0911 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002) - HFP-VSL-00002 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-1006, -1007, -1010, and -1011 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002)	**(GTC)** The in-cave HFP equipment shall be capable of being remotely operated/monitored.		PCJ operating HSH operating

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
		- HFP-VSL-00005 (MFPV) - Sparger Main Header Flow Meters CTNs: HFP-FT-2906, -2907, -2910, and -2911 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002) - HFP-VSL-00006 (MFV) - Sparger Main Header Flow Meters - CTNs: HFP-FT-3006, -3007, -3010, and -3011 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002) <u>Status (go no-go, position valve open closed, motor on/off)</u> • ADS Pumps - CTNs: HFP-PMP-00001, -00002, -000014, and -00015. • Sample/Transfer Pumps - CTNs: HFP-PMP-00005A, -00005B, -00007, -00017, -00018A, and -00018B. • HLP Transfer Pumps - CTNs: HLP-PMP-00019A and HLP-PMP-00019B • Glass Former Feed Isolation Valves - CTNs: HFP-YV-0105 and HFP-YV-2105 • MFPV Feed Diversion Valves - CTNs: HFP-YV-0103 and HFP-YV-2103 • HLP Transfer Pumps - CTNs: HLP-PMP-00019A and HLP-PMP-00019B • MFV Transfer/Sample Recirc Line - Three Way Valves – CTNs: HFP-YV-0040, -0039, -2040, and -2039 • Safety Air Control Valves - CTNs: HFP-YV-0903,-0931, -0904, and -0932 (HFP-RK-00016, 24590-HLW-M6-HFP-00009002), CTNs: HFP-YV-1003, -1031, -1004, and -1032 (HFP-RK-00017, 24590-HLW- M6-HFP-00010002), CTNs: HFP-YV-2903, -2931, -2904, and -2932 (HFP-RK-00018, 24590-HLW- M6-HFP-20009002), CTNs: HFP-YV-3003, -3031, -3004, and -3032 (HFP-RK-00019, 24590-HLW- M6-HFP-20010002) • ASX three-way valves (ASX-YV-3202, -3203, -3204, -3302, -3303, and -3304) in ASX system • Steam Ejector Steam Supply Valves – HFP-YV-0049, HFP-YV-0033, HFP-YV-2033, and HFP-YV-2049 • Mechanical Agitators - HFP-AGT-00001, HFP-AGT-00002, HFP-AGT-00004, and HFP-AGT-00005			
3.10.4.2	SU/COM	Demonstrate all PPJ monitoring and control functions are forwarded to the PCJ.	(**GTC**) PPJ monitoring and control functions are forwarded to the PCJ.	Recommended to be performed in conjunction with individual PPJ requirements.	PCJ/PPJ operating
3.10.4.4	SU/COM	Test automatic flushing operations post-transfer and post-sampling for each transfer/sampling line.	(**GTC**) HFP (pumps, valves, etc.) operate as intended, for the correct amount of time (i.e., to obtain correct flush volume), and return to a normal state at the conclusion of flushing. Automated flushes of the MFV to melter occur at **TBD** intervals.	Flush durations acceptance criteria need to be determined for each line in the test plan.	Integrated water runs
3.11.2.1.1	SU/COM	Demonstrate the air amplifiers are activated by the seismic signal will be performed in requirement 3.10.2.1.4 and maintain headspace negative relative to C3 ventilated areas which will be performed in requirement 3.11.3.1.1. CTNs: HFP-EJCT-00006, -00007, -00008, and -00009.	(**TAC**) The air amplifiers are automatically activated by the seismic shutdown signal.	This will be performed during the verification of requirement 3.10.2.1.4	See Requirement 3.10.2.1.4
3.11.3.1.1	SU/COM	Demonstrate the air amplifiers maintain negative pressure in the HFP vessels relative to the C3 zones when the facility is in seismic shutdown response mode. CTNs: HFP-EJCT-00006, -00007, -00008, and -00009.	(**GTC**) The air amplifiers maintain negative pressure in the HFP vessels relative to the C3 areas when the facility is in seismic shutdown response mode.		PPJ operating and monitoring SC ISA airflow PCJ operating and monitoring HFP vessel pressure SC ISA operating

Requirement (para #)	SU or COM	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
					Demonstrate during post seismic conditions: All 4 amplifiers on, One vessel in emergency sparge mode Glass Former air supply line on. **(TBD)** Simulate broken supply lines into C3 areas.

Appendix B Descriptions of System Functional Flow and Interactions

Function: A.1	Receive/Store Treated HLW Concentrate
Detailed description: The HLW operator determines the size of the batch volume to be transferred. This function will align the valves in the transfer path to send the HLW waste stream to the selected melter train. The operator initiates the transfer and monitors for leaks and vessel levels in HLP and HFP melter feed preparation vessels (MFPV) (HFP-VSL-00001/00005). The transfer terminates when the level in the MFPV hits the expected height, when a line leak is detected, or when a volume balance mismatch occurs during transfer. A single line volume flush is processed forward to the MFPV followed by a two line volume transfer using demineralized water back to the PWD vessel in the PT Facility.	
Initiation: This function initiates when an HLW batch is determined by the operator to be ready and the HLW operator issues a permissive signal.	
Termination: This function terminates when the minimum volume of flush water has run through the transfer pipe from the PT Facility to the HLW Facility (See Function B.1).	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; line flushing from the PT Facility PWD.	
Applicable Modes: Normal operations	

Function: A.2	Mix Treated HLW Concentrate
Detailed description: Mixing must occur before sampling in order to obtain a representative sample. The mechanical agitator mixes the waste for a predetermined amount of time. Additionally, the ISA provides idle purge airflow through the sparge tubes in order to agitate the waste and release trapped hydrogen gas from waste that settles on the bottom of the vessel. Upon loss of a mechanical agitator, the ISA provides air for emergency sparge mode (at least 42 scfm) intermittently to prevent an episodic release of hydrogen.	
Initiation: This function initiates during the HLW concentrate transfer to the MFPVs.	
Termination: This function does not terminate unless the agitator stops rotating due to operator action or a malfunction/accident.	
Parallel or sequential functions: Transfer of HLW concentrate to MFPVs; sampling of HLW concentrate.	
Applicable Modes: Normal operations; seismic DBE accident conditions	

Function: A.3	Sample Treated HLW
Detailed description: The operator chooses which MFPV and associated transfer pump to use in order to obtain a sample. Operational pre-checks are performed to ensure the system is ready to sample. The priming line valve in the chosen transfer/recirculation pump is opened allowing priming demineralized water to flow through the pump before the waste. The pump then recirculates waste through the auto sampler for a minimum of 10 minutes to get a representative sample. The ASX takes samples, which are then analyzed to determine the waste characteristics and provide the glass former recipe.	
Initiation: This function initiates after the MFPVs receive HLW concentrate and mix the waste for a predetermined amount of time.	
Termination: This function terminates after a predetermined amount of time upon completion of sampling.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; demineralized water addition to the MFPV via the ASX sample line flush	
Applicable Modes: Normal operations	

Function: A.4	Receive Glass Formers
Detailed description: The glass formers are added to the MFPV by the GFR. The process of composing a batch of glass formers is out of the scope of this document.	
Initiation: This function initiates after the Lab determines the glass former recipe based on ASX samples from either the initial HLW concentrate transfer or an already blended and resampled melter feed batch.	

Termination: This function terminates when the batch of glass formers are finished being added to the MFPV.
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling
Applicable Modes: Normal operations

Function: A.5	Mix Glass Formers and HLW Concentrate
Detailed description: The MFPV agitator is operating at all times and mixes the glass former batch with the treated HLW concentrate in order to obtain a representative sample. The agitator speed is used to determine the addition rate of the glass formers. The PCJ and PPJ monitor the agitator speed and power.	
Initiation: This function initiates when the glass formers are added to the MFPV.	
Termination: This function does not terminate unless the agitator stops rotating due to operator action or a malfunction/accident.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; and addition of demineralized water	
Applicable Modes: Normal operations; seismic DBE accident conditions	

Function: A.6	Sample HLW Melter Feed
Detailed description: Mixing must occur before sampling in order to obtain a representative sample. The operator chooses which MFPV and associated transfer pump to use in order to obtain a sample. Operational pre-checks are performed to ensure the system is ready to sample. The priming line valve in the chosen transfer/recirculation pump is opened allowing priming demineralized water to flow through the pump before the waste. The pump then recirculates waste through the autosampler for a minimum of 10 minutes to get a representative sample. The ASX takes samples which are then analyzed to determine the waste characteristics and provide the glass former recipe.	
Initiation: This function initiates after the MFPVs receive the glass former batch and mix the glass formers with the HLW concentrate for a predetermined amount of time in order to obtain a representative sample.	
Termination: This function terminates when the ASX flush valve is opened and directs a line flush of the recirculation line and transfer/recirculation pump.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; demineralized water addition to the MFPV via the ASX sample line flush	
Applicable Modes: Normal operations	

Function: A.7	Transfer HLW Melter Feed to MFVs
Detailed description: The MFPV transfers a batch of melter feed to the MFV at a rate of at least 44 gpm. The transfer begins by the operator determining the sending vessel (MFPV), the sample/transfer pump to be used, and the receiving vessel (MFV). Operational pre-checks are performed to ensure the system is ready to transfer. The operator then aligns the valves in the transfer route and enters the volume to be transferred into a flow totalizer. The priming line valve in the chosen transfer/sample pump is opened allowing priming demineralized water to flow through the pump before the waste. After a predetermined amount of time, the priming valve is closed and allows the HLW melter feed to be transferred to the MFV.	
Initiation: This function initiates once the MFPV HLW melter feed is within the acceptable limits for glass production.	
Termination: This function terminates when the approved batch volume has been transferred from the MFPV to MFV.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; and addition of demineralized water	
Applicable Modes: Normal operations	

Function: A.8	Receive/Store HLW Melter Feed
Detailed description: The MFV receives and stores a batch of melter feed from the MFPV. Operational pre-checks are performed to ensure the system is ready to transfer. The operator then aligns the valves in the transfer route and enters the volume to be transferred into a flow totalizer. The priming line valve in the chosen transfer/sample pump is opened allowing priming demineralized water to flow through the pump before the waste. After a predetermined amount of time, the priming valve is closed and allows the HLW melter feed to be transferred to the MFV.	
Initiation: This function initiates when an HLW melter feed batch is approved ready to transfer to the MFV.	

Termination: This function terminates when the approved batch volume has been transferred.
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; and addition of demineralized water
Applicable Modes: Normal operations

Function: A.9	Mix HLW Melter Feed
Detailed description: The mechanical agitator mixes the waste in order to obtain a representative sample. Additionally, the ISA provides idle purge airflow through the sparge tubes in order to agitate the waste and release trapped hydrogen gas from waste that settles on the bottom of the vessel. Upon loss of a mechanical agitator, the ISA provides air for emergency sparge mode (at least 42 scfm) intermittently to prevent an episodic release of hydrogen.	
Initiation: This function initiates during the HLW melter feed transfer from the MFPV to the MFV.	
Termination: This function does not terminate unless the agitator stops rotating due to operator action or a malfunction/accident.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling	
Applicable Modes: Normal operations; seismic DBE accident conditions	

Function: A.10	Transfer HLW Melter Feed to Melters
Detailed description: The ADS pumps constantly pump the melter feed into the melters. There are two ADS pumps per melter train. The pumps operate in cycles instead of both operating at the same time.	
Initiation: This function initiates when there is HLW melter feed in the MFV and the operator starts the transfer to the melter.	
Termination: This function terminates if a non-routine event interrupts operations or if the level in the MFV gets too low.	
Parallel or sequential functions: Mixing by the agitators; idle air purging; vessel cooling; addition of demineralized water for line flushing	
Applicable Modes: Normal operations	

Function: B.1	Flush HCP transfer line [**HOLD**]
Detailed description: The transfer piping from the PT Facility will be flushed after a waste transfer to HLW in order to prevent plugging. The flush water will be directed back to the PT Facility by a three-way valve once the line to the MFPV is flushed. The volume of water to be used for the flush is three times the line volume.	
Initiation: This function initiates after the HLW concentrate is transferred to the MFPV.	
Termination: This function terminates when the required flush volume of demineralized water has flowed through the transfer pipe.	
Parallel or sequential functions: N/A	
Applicable Modes: Normal, abnormal, and maintenance operations	

Function: C.1	Provide Vessel Overflow Path to a Sump
Detailed description: The HFP vessels are equipped with overflow lines. These lines will be used in the event that too much waste gets transferred from either the PT Facility HLP to the MFPV or the MFPV to the MFV. The overflow lines empty to a sump in the floor of the bermed area in the melter caves.	
Initiation: This function initiates when the volume of waste exceeds the normal operating levels and spills out of the HFP vessels into the melter cave.	
Termination: This function terminates when the vessel content level drops below the overflow line.	
Parallel or sequential functions: N/A	
Applicable Modes: Abnormal operations; seismic DBE accident conditions	

Function: D.1	Supply Demineralized Water
Detailed description: The PWD system provides demineralized water to the HFP vessels, spargers, and pumps. The demineralized water is used to prime the sample/transfer pumps in the HFP vessels. The demineralized water can be used to flush the spargers if they become plugged. The demineralized water is also used to dilute the waste in the HFP vessels if an out-of-specification waste sample is obtained.	
Initiation: This function initiates when the sample/transfer pumps are primed, to remove a sparge tube plug, or to dilute the vessel contents.	
Termination: This function terminates when the pumps are fully capable of producing the necessary head to pump waste, the sparge tube plug has been removed, or when the vessel contents are diluted and transferred out of the vessel.	
Parallel or sequential functions: N/A	
Applicable Modes: Normal, abnormal, and maintenance operations	

Function: D.2	Clean Empty HFP Vessels
Detailed description: The HFP vessels are washed using demineralized water and nitric acid, if needed, from the PWD and NAR systems. The washwater is processed forward to the melters during normal operations or transferred from the HFP vessels to the RLD using the steam ejectors during vessel decommissioning. The vessels are equipped with wash rings to allow decontamination.	
Initiation: This function initiates when the HFP vessels are determined to be in need of replacement.	
Termination: This function terminates when the HFP vessels are sufficiently decontaminated.	
Parallel or sequential functions: N/A	
Applicable Modes: Maintenance operations; decontaminating and decommissioning (D&D)	

Function: E.1	Flush Sample/Transfer Line [**HOLD**]
Detailed description: The HFP vessel sample recirculation loops, sample/transfer pumps, and transfer line from the MFPV to MFV are flushed using demineralized water to prevent the pumps and lines from plugging. The ASX initiates the flush and the water goes to the HFP vessels.	
Initiation: This function initiates after the ASX has obtained a representative sample of the HLW concentrate or when a transfer from MFPV to MFV is completed.	
Termination: This function terminates when sample/transfer line and pump have been flushed with the required amount of demineralized water.	
Parallel or sequential functions: N/A	
Applicable Modes: Normal operations	

Function: F.1	Transfer HFP Vessel Contents
Detailed description: The HFP vessel contents are removed and transferred to the other melter train either upon receipt of an out-of-spec batch sample analysis or to de-inventory the waste. Out-of-spec batch transfers are performed only when there is no capability to adjust the MFPV contents to achieve a conforming waste batch. De-inventory waste transfers are performed when a HFP vessel or melter becomes unavailable on one melter train.	
Initiation: This function initiates when the HLW melter feed batch is out-of-spec or if it needs to be de-inventoried.	
Termination: This function terminates when the transfer to the operating melter train is complete.	
Parallel or sequential functions: N/A	
Applicable Modes: Abnormal operations	

Function: G.1	Flush Melter Transfer Line [**HOLD**]
Detailed description: The transfer piping between the ADS pump in the MFV and the HLW melter will be flushed during and after transferring the melter feed. The ADS pumps will be flushed with demineralized water every 4 hours during a transfer. Demineralized water is also added during the feed transfer in order to lower the melter plenum temperature below 800 °C.	
Initiation: This function initiates intermittently during melter feed transfer to the HLW melter.	
Termination: This function terminates when the predetermined flush volume is transferred to the HLW melter.	
Parallel or sequential functions: Transferring HLW melter feed to the melters.	
Applicable Modes: Normal operations	

Function: H.1	Remove Washwater from the HFP Vessels
Detailed description: High pressure steam is supplied to the steam ejectors in the HFP vessels to allow for removal of the vessel contents during vessel decommissioning. The contents are transferred to RLD-VSL-00008. The volume of the transfer is specified by the operator. Then the available volume in RLD-VSL-00008 is determined. After that, the operator initiates the transfer. If the volume in the MFPV is low enough to allow dilution, the transfer will occur from the MFPV to RLD-VSL-00008. If the volume in the MFPV is too high, the waste will be pumped to the MFV, which will act as a dilution vessel. A limited amount of waste will be transferred to the MFV and then diluted and transferred to RLD-VSL-00008 by the steam ejectors. This will repeat until the volume in the MFPV is low enough to allow dilution. During normal operations, vessel washwater is processed forward to the melters with melter feed.	
Initiation: This function initiates when the vessels are washed for D&D, an out-of-spec batch is received, or in an unforeseen event needing the emptying of an HFP vessel.	
Termination: This function terminates when the transfer is complete.	
Parallel or sequential functions: N/A	
Applicable Modes: Abnormal and maintenance operations; D&D	

Function: I.1	Idle Air Purge to Vessel Spargers [**HOLD**]
Detailed description: The ISA provides idle purge airflow through the sparge tubes in order to agitate the waste and release trapped hydrogen gas from waste that settles on the bottom of the vessel. The air rises up through the waste and eventually gets ventilated from the vessel by the HOP and PVV. This aids in removing hydrogen from the headspace.	
Initiation: This function initiates when HLW concentrate is transferred to the HFP vessels.	
Termination: This function terminates temporarily when a loss of a mechanical agitator occurs or when the vessel contents are removed for any reason.	
Parallel or sequential functions: Transferring waste to the MFPV, MFV, and melter; mixing the waste with the agitator; adding glass formers.	
Applicable Modes: Normal operations; seismic DBE accident conditions where the mechanical agitators remain functioning	

Function: I.2	Emergency Air Sparging to Vessel Spargers [**HOLD**]
Detailed description: Upon loss of a mechanical agitator, the SC ISA provides air for emergency sparge mode (at least 42 scfm) intermittently to prevent an episodic release of hydrogen. Emergency sparging lasts for a predetermined amount of time and then the airflow drops back down to idle purge flow. The air rises up through the waste and eventually gets ventilated from the vessel by the HOP and PVV or the air amplifiers which vent to the melter cave. This aids in removing hydrogen from the headspace.	
Initiation: This function initiates when the mechanical agitators in the HFP vessels are not functioning for any reason. Emergency sparging is initiated after (time - **TBD**) before reaching the LFL.	
Termination: This function terminates when the mechanical agitator is functioning again.	
Parallel or sequential functions: None	
Applicable Modes: seismic DBE accident conditions where the mechanical agitators are not functioning	

Function: I.3	Supply air to control valves, instruments, ADS pumps, and air amplifiers
Detailed description: The ISA system provides air to the HFP control valves, instruments, ADS pumps, and air amplifiers. Air is used to provide the motive force to open/operate control valves, instruments, ADS pumps, and air amplifiers.	

Initiation: This function initiates when the PCJ/PPJ system transmits a signal to open/operate the control valves, instruments, ADS pumps, or air amplifiers.
Termination: This function terminates when the PCJ/PPJ system transmits a signal to terminate operation/close the control valves, instruments, ADS pumps, or air amplifiers.
Parallel or sequential functions: None
Applicable Modes: Normal operations; seismic DBE accident conditions

Function: I.4	Supply idle air to purge to MFPV GFR supply line
Detailed description: The ISA system provides continuous idle air to purge to MFPV GFR supply line. Air is used to prevent backflow of contamination from the MFPVs to the GFR during normal operation.	
Initiation: This function initiates when HLW concentrate is transferred to the HFP vessels.	
Termination: This function terminates when the vessels are being decontaminated for removal and do not contain any waste or if vessel the contents temperature falls below the minimum operating temperature.	
Parallel or sequential functions: Transferring waste to the MFPV, MFV, and melter; mixing the waste with the agitator; adding glass formers.	
Applicable Modes: Normal operations; seismic DBE accident conditions	

Function: J.1	Ventilate HFP Vessel Offgas
Detailed description: The HOP and PVV ventilate the HFP vessels to remove hydrogen from the headspace. The functions of the HOP/PVV are not included in the scope of this document. If the HOP/PVV goes offline for any reason, the vessel has air amplifiers and an overflow feature with a flapper valve that will be used to vent the vessel gases to the melter cave. The air amplifiers maintain negative pressure in the headspace and draw the air out. The overflow feature flapper valve is a passive device that opens when the pressure inside the vessel is greater than that of the melter cave and allows the headspace to vent to the melter cave and C5V. Demisters are used to prevent excessive moisture and aerosols from being carried out of the HFP vessels into the HOP HEPA filters.	
Initiation: This function initiates when the HFP vessels contain HLW concentrate or a blended batch of HLW melter feed. If the HOP/PVV is not operating, the air amplifiers activate and vent the headspace. The overflow feature flapper valve is passive and will initiate ventilation when the pressure in the headspace becomes positive.	
Termination: This function terminates when the vessels are empty.	
Parallel or sequential functions: Transferring waste to the MFPV, MFV, and melter; mixing the waste with the agitator; adding glass formers; providing idle purge and emergency sparge air	
Applicable Modes: Normal operations; seismic DBE accident conditions	

Function: K.1	Cool HFP Vessel Contents
Detailed description: The PCW provides cooling water to the HFP vessel cooling jackets. The cooling jackets remove radioactive decay heat and heat generated by the agitator motor. Water is constantly flowing through the cooling jackets as long as there is waste in the HFP vessels. The cooling water supplied to the jackets is in a secondary loop to reduce the probability of spreading radiation contamination to the Balance of Facilities.	
Initiation: This function initiates when the waste is transferred to the MFPVs and MFVs.	
Termination: This function terminates when the vessels are being decontaminated for removal and do not contain any waste or if vessel the contents temperature falls below the minimum operating temperature.	
Parallel or sequential functions: Transferring waste to the MFPV, adding glass formers to the MFPV, mixing the waste with the agitator and sampling the MFPV waste.	
Applicable Modes: Normal operations	

Function: L.1	Receive Electrical Power
Detailed description: Electrical power to the HFP equipment and instruments is supplied by the LVE.	
Initiation: This function initiates when the HLW Facility is in startup operations.	
Termination: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: All modes	

Function: M.1	PCJ - Normal Controls to Support Monitoring, Control, and Communication
Detailed description: Non-safety monitoring and control functions are supported by the PCJ. Components that are controlled automatically by the PPJ are also monitored by the PCJ during normal operations. The functions that are monitored and controlled by the PCJ are: • Measure the temperature, pressure, and level of the vessel contents • Measure the vessel headspace pressure • Operate valves for transferring and sampling • Communicate with the PT Facility to allow/terminate HLW concentrate transfers • Operate the mechanical agitators • [**HOLD**] Measure mechanical agitator power • Operate the sample/transfer pumps • [**HOLD**] Operate the ADS pumps • [**HOLD**] Monitor the airflow through the sparge tubes • [**HOLD**] Measure air sparger flow rate • Operate the steam supply to the steam ejectors • Operate the cooling water supply • Measure the cooling water flow rate • Measure the ASX sample line velocity • [**HOLD**] Operate safety air valves for spargers	
Initiation: This function initiates when the HLW Facility is in startup operations.	
Termination: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: Not credited for DBE	

Function: M.2	PPJ - Safety Instrumented Functions and Alarms to Support Monitoring, Control, and Communication
Detailed description: Automatic Safety monitoring and control functions are supported by the PPJ. The functions that are monitored and controlled by the PPJ are: • Terminate HLW concentrate transfers • [**HOLD**] Measure mechanical agitator speed and power • [**HOLD**] Monitor the airflow through the sparge tubes and switch from idle purge to emergency sparge mode • [**HOLD**] Operate safety air valves for sparging to transition from non-safety ISA to safety ISA • [**HOLD**] Seismic signal interlock	
Initiation: This function initiates when the HLW Facility is in startup operations.	
Termination: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: Abnormal	

Appendix C Active Safety Instruments and Functions

The listed instruments are designated as having active safety functions, implemented through interface with and programming in the PPJ system. Information in the table below reflects the current design of active safety instruments, including functions, and safety designations per the P&IDs and associated equipment and instrument lists. In some cases the current safety classification of the SSCs in design is known to exceed the design requirements. The information will be updated as needed to reflect changes to the design. The information below is provided in support of Plant Engineering and Operations and does not represent design requirements.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 1 Feed Prep Vessel High Level Interlocks - Train A	SC	HFP-LT-0050	HFP-YV-0105 via YC-0105B HFP-YV-0103 via YC- 0103B	High level closes valves.
Melter 1 Feed Prep Vessel High Level Interlocks - Train B	SC	HFP-LT-0111 HFP-DT-0008	HFP-YV-0105 via YC-0105C	High level close valve.
Melter 2 Feed Prep Vessel High Level Interlocks - Train A	SC	HFP-LT-2050	HFP-YV-2105 via YC-2105B HFP-YV-2103 via YC- 2103B	High level closes valves.
Melter 2 Feed Prep Vessel High Level Interlocks - Train B	SC	HFP-LT-2111 HFP-DT-2008	HFP-YV-2105 via YC-2105C	High level close valve.
Melter 1 Feed Vessel High Level Interlocks - Train A	SC	HFP-LT-0047	HFP-PMP-00005A & B via HFP-JY-0106A & 0107A	High level stops pumps.
Melter 1 Feed Vessel High Level Interlocks - Train B	SC	HFP-LT-0207 HFP-DT-0013	HFP-PMP-00005A & B via HFP-JY-0106B & 0107B	High level stops pumps.
Melter 2 Feed Vessel High Level Interlocks - Train A	SC	HFP-LT-2047	HFP-PMP-00018A & B via HFP-JY-2106A & 2107A	High level stops pumps.
Melter 2 Feed Vessel High Level Interlocks - Train B	SC	HFP-LT-2207 HFP-DT-2013	HFP-PMP-00018A & B via HFP-JY-2106B & 2107B	High level stops pumps.
Melter 1 Feed Prep Vessel Loss of Agitator / Sparge Interlock - Train A	SC	HFP-JT-0706 HFP-ST-0062	HFP-YV-0103 via YC-0103B HFP-YV-0105 via YC-0105B HFP-YV-0903 via YC-0903	Loss of agitation (speed or power) close valves -0103 and -0105 then after time **TBD**, open valve -0903 for **TBD**, then repeat.
Melter 1 Feed Prep Vessel Loss of Agitator / Sparge Interlock - Train B	SC	HFP-JT-0707 HFP-ST-0701	HFP-YV-0103 via YC-0103C HFP-YV-0105 via YC-0105C HFP-YV-0904 via YC-0904	Logic as above. YV-0904 is sparge valve.
Melter 2 Feed Prep Vessel Loss of Agitator / Sparge Interlock - Train A	SC	HFP-JT-2706 HFP-ST-2062	HFP-YV-2103 via YC-2103B HFP-YV-2105 via YC-2105B HFP-YV-2903 via YC-2903	Logic as above. YV-2903 is sparge valve.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 2 Feed Prep Vessel Loss of Agitator / Sparge Interlock - Train B	SC	HFP-JT-2707 HFP-ST-2701	HFP-YV-2103 via YC-2103C HFP-YV-2105 via YC-2105C HFP-YV-2904 via YC-2904	Logic as above. YV-2904 is sparge valve.
Melter 1 Feed Vessel Loss of Agitator / Sparge Interlock - Train A	SC	HFP-JT-0806 HFP-ST-0063	HFP-YV-1003 via YC-1003	Loss of agitation (speed or power), after time **TBD**, open valve -0903 for **TBD**, then repeat
Melter 1 Feed Vessel Loss of Agitator / Sparge Interlocks - Train B	SC	HFP-JT-0807 HFP-ST-0801	HFP-YV-1004 via YC-0104	Logic as above
Melter 2 Feed Vessel Loss of Agitator / Sparge Interlock - Train A	SC	HFP-JT-2806 HFP-ST-2063	HFP-YV-3003 via YC-3003	Loss of agitation, after time **TBD** minutes open valve YV-2003 for **TBD** minutes and repeat.
Melter 2 Feed Vessel Loss of Agitator / Sparge Interlocks - Train B	SC	HFP-JT-2807 HFP-ST-2801	HFP-YV-3004 via YC-3004	Loss of agitation (speed or power), after time **TBD** minutes open valve YV-2004 for **TBD** minutes and repeat.
Melter 1 Feed Prep Vessel Low Sparge Alarm - Train A	SC	FT-0907	HFP-YV-0903 via YC-0903	When valve open if flow low - alarm.
Melter 1 Feed Prep Vessel Low Sparge Alarm - Train B	SC	FT-0906	HFP-YV-0904 via YC-0904	As above
Melter 2 Feed Prep Vessel Low Sparge Alarm - Train A	SC	FT-2907	HFP-YV-2903 via YC-2903	As above
Melter 2 Feed Prep Vessel Low Sparge Alarm - Train B	SC	FT-2906	HFP-YV-2904 via YC-2904	As above
Melter 1 Feed Vessel Low Sparge Alarm - Train A	SC	FT-1007	HFP-YV-1003 via YC-1003	As above
Melter 1 Feed Vessel Low Sparge Alarm - Train B	SC	FT-1006	HFP-YV-1004 via YC-1004	As above
Melter 2 Feed Vessel Low Sparge Alarm - Train A	SC	FT-3007	HFP-YV-3003 via YC-3003	As above
Melter 2 Feed Vessel Low Sparge Alarm - Train B	SC	FT-3006	HFP-YV-3004 via YC-3004	As above
Melter 1 Feed Prep Vessel Low Purge Interlocks - Train A	SC	FT-0911	YV-0931	Low flow open valve
Melter 1 Feed Prep Vessel Low Purge Interlocks - Train B	SC	FT-0910	YV-0932	Low flow open valve
Melter 2 Feed Prep Vessel Low Purge Interlocks - Train A	SC	FT-2911	YV-2931	Low flow open valve
Melter 2 Feed Prep Vessel Low Purge Interlocks - Train B	SC	FT-2910	YV-2932	Low flow open valve
Melter 1 Feed Vessel Low Purge Interlocks - Train A	SC	FT-1011	YV-1031	Low flow open valve
Melter 1 Feed Vessel Low Purge Interlocks - Train B	SC	FT-1010	YV-1032	Low flow open valve
Melter 2 Feed Vessel Low Purge Interlocks - Train A	SC	FT-3011	YV-3031	Low flow open valve
Melter 2 Feed Vessel Low Purge Interlocks - Train B	SC	FT-3010	YV-3032	Low flow open valve
Melter 1 PVV/PVP Pressure Interlocks	SS	PT-0052	YV-0105	Low of vacuum close valve
Melter 2 PVV/ PVP Pressure Interlocks	SS	PT-2052	YV-2105	Loss of vacuum close valve
Auto sampler ASX-SMPLR-00029 High Level Interlocks - Train A	SC	From ASX System – LT-3240	HFP-PMP-00005A & B via HFP-JY-0106A & 0107A HFP-PMP-00007 via JY-0201A	On detection of high level stop pumps.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Auto sampler ASX-SMPLR-00029 High Level Interlocks - Train B	SC	From ASX System – LT-(**TBD**)	HFP-PMP-00005A & B Via HFP-JY-0106B & 0107B HFP-PMP-00007 via JY-0201B	On detection of high level stop pumps.
Auto sampler ASX-SMPLR-00042 High Level Interlocks - Train A	SC	From ASX System – LT-3340	HFP-PMP-00018A & B via HFP-JY-2106A & 2107A HFP-PMP-00017 via JY-02203A	On detection of high level stop pumps.
Auto sampler ASX-SMPLR-00042 High Level Interlocks - Train B	SC	From ASX System – LT-(**TBD**)	HFP-PMP-00018A & B via HFP-JY-2106B & 2107B HFP-PMP-00017 via JY-2203B	On detection of high level stop pumps.
Auto sampler ASX-SMPLR-0029 Flush valve interlock position 4	SS	ASX-ZSH-3202 HFP-IT-0118	HFP-PMP-0005A via JY-0106B	If pump running and auto sampler in position, stop pump.
Auto sampler ASX-SMPLR-0029 Flush valve interlock position 5	SS	ASX-ZSL-3203 HFP-IT-0119	HFP-PMP-0005B via JY-0107B	If pump running and auto sampler in position stop pump.
Auto sampler ASX-SMPLR-0029 Flush valve interlock position 6	SS	ASX-ZSL-3204 HFP-IT-0208	HFP-PMP-0007 via JY-0203B	If pump running and auto sampler in position stop pump.
Auto sampler ASX-SMPLR-0042 Flush valve interlock position 4	SS	ASX-ZSH-3302 HFP-IT-2118	HFP-PMP-00018B via JY-2106A	If pump running and auto sampler in position stop pump.
Auto sampler ASX-SMPLR-0042 Flush valve interlock position 5	SS	ASX-ZSL-3303 HFP-IT-2119	HFP-PMP-0018A via JY-2107A	If pump running and auto sampler in position stop pump.
Auto sampler ASX-SMPLR-0042 Flush valve interlock position 6	SS	ASX-ZSL-3304 HFP-IT-2208	HFP-PMP-0017 via JY-2203A	If pump running and auto sampler in position stop pump.
Seismic Isolation Interlocks Train A	SC	Sensors - part of seismic system. Manual activation	1. Open air amplifier valves YV-0925, 1025, 2925 and 3025. 2. Close HFP GFR valve YV-0105 3. Valves YV-0903, 0904,1003 and 1004	Actions on valves listed as item 1 and 2 are immediate, following activation. Actions on valves listed in 3 are delayed **TBD** hours and then each valve in turn opened for a fixed time **TBD**, then repeat every **TBD** hours.
Seismic Isolation Interlocks Train B	SC	Sensors - part of seismic system. Manual activation	1. Open air amplifier valves YV-0928, 1028, 2928 and 3038. 2. Close HFP GFR valve YV-2105 3. Valves YV-2903, 2904, 3003 and 3004	As above

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Terminate Transfer to Melter	SS	PDT-0139A PDT-0139B PDT-2139A PDT-2139B	HFP-PMP-00001, HFP-PMP-00002, HFP-PMP-00014, & HFP-PMP-00015	Stop the pumps when a high pressure setpoint is reached.
MFPV Feed Diversion Valve - High-High Liquid Level Safety Significant Interlock-HFP-VSL-00001	SS	HFP-LT-0111 HFP-LT-0050 HFP-LT-0051	HFP-YV-0103 via YC-0103A and YC-0103B, HFP-YV-0105 via YC-0105B and YC-0105B	Isolates feed into the MFPV from the PT facility and GFR system
MFPV Feed Diversion Valve - High-High Liquid Level Safety Significant Interlock- HFP-VSL-00005	SS	HFP-LT-2111 HFP-LT-2050 HFP-LT-2051	HFP-YV-2103 via YC-2103A and YC-2103B, HFP-YV-2105 via YC-2105B and YC-2105B	Isolates feed into the MFPV from the PT facility and GFR system

Notes:
Many of the instruments above are located on instrument racks. These include: HFP-RK-0003, 0005, 0006, 0009 and 0013.

Appendix D Reserved-System Procedures

Appendix E Reserved-System History

Attachment 2
16-ECD-0048
(102 Pages Excluding Cover Sheet)

HLW Radioactive Liquid Waste Disposal System (RLD) Design Description

24590-HLW-3ZD-RLD-00001

ISSUED BY
RPP-WTP PDC

HLW Radioactive Liquid Waste Disposal System (RLD) Design Description

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Checked by:	Claude Kabera
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Concurrence:	Mark Johnson
Concurrence signature:	Manager of Production Engineering Signature — Date 3/28/16
Concurrence:	Ian Milgate
Concurrence signature:	Project Technical Director and Design Authority Signature — Date 3/28/16
Approved by:	Natalie Harkey
Approver's position:	System Engineering Manager
Approver's signature:	Signature — Date 3/29/2016

Validation - signatures below indicate acceptance of the requirements established in Section 3 as the complete and correct set of requirements for this system relative to the requirement sources for which the Requirement Developer is responsible.

Appl.	Requirement Area	Requirement Developer	Signature	Date
☐	Architectural Design			
☐	Civil/Structural Design			
☒	Controls & Instrumentation Design	Wayne Underhill	e-mail concurrence	9/24/15
☐	Electrical Design & AHJ			
☐	Fire Protection Engineering			
☐	HVAC Design			
☒	Mechanical Handling Design	Julian Leam	e-mail concurrence	9/21/15
☒	Mechanical Systems Design	Julian Leam	e-mail concurrence	9/21/15
☒	Plant Design	John Schuette	e-mail concurrence	9/29/15
☒	Process Engineering	~~Bob Voke~~ Eric Sloathaug	e-mail concurrence	9/28/15
☐	Interface (External)			
☐	Interface (Internal)			
☒	System Functions and Requirements	Jason Appleby		3/23/16
☒	Equipment Environmental Qualification	Govind Rajagopal	G. Rajagopal	9-30-15
☒	Materials Engineering / Technology	Debbie Adler	email concurrence	9/23/15
☐	Plant Software Design			
☒	Environmental Protection (ESH)	Barry Curn	e-mail concurrence	10/5/15
☒	Nuclear Safety Engineering MLW 10/1/15	Scott Manley		10-1-15
☐	Criticality Safety			
☒	Radiological Engineering	Kyle Peltier	e-mail concurrence	9/23/15
☐	Industrial Safety/Hygiene (ESH)			
☐	Mission (WTP Contract functional/ performance rqmts)			
☒	Operations Requirements Document (Plant Ops)	Dan Rovira	e-mail concurrence	9/23/15
☒	Quality Assurance	Virginia Cleary-Ivanoff	e-mail concurrence	9/21/15
☐	Safeguards & Security			
☐	Startup			
☐	Transportation & Logistics			

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History Sheet

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0	Issued for use. (No revision bars shown) • Removed HOLDs and incorporated changes associated with updates to 24590-WTP-PSAR-ESH-01-002-04, Rev. 5i • Updated safety requirements per preliminary safety basis change package 24590-HLW-PDACP-NS-15-0002. • Added and removed requirements as a result of the hazard analysis and control selection performed in support of 24590-HLW-PDACP-NS-15-0002. • Updated references. • General update to format, requirements, and boilerplate text, consistent with current guidance and lessons learned. • Incorporates 24590-WTP-ATS-MGT-13-0193. • Added Section 4.	J. Hernandez
A	Initial issue. Supersedes 24590-HLW-3YD-RLD-00001 Rev 4, *System Description for the HLW Radioactive Liquid Waste Disposal System RLD.*	C. Kabera / D. Reid

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1 Introduction

1.1 System Identification

This system design description (SDD) defines the technical and functional/performance requirements of the high-level waste radioactive liquid waste disposal system (HLW-RLD). This document details waste treatment requirements, environmental compliance requirements, and authorization basis requirements of the HLW-RLD system. This document describes the process and functional design requirements of the HLW-RLD system, including the following:

- Services and utility requirements, operating materials and supplies, and other external interfaces
- Operations limits and design bases
- Other criteria and requirements pertinent to the design of the facility, exclusive of internal systems

The HLW-RLD system receives radioactive effluents from the HLW melter offgas treatment process system (HOP), the HLW canister decontamination handling system (HDH), the HLW melter cave support handling system (HSH), HLW nonradioactive liquid waste disposal system (NLD) out-of-specification streams, radioactively contaminated blowdown from the plant cooling water system (PCW), sample line flushes from the autosampling (ASX) system, and periodic plant and vessel washes within the HLW Facility. The boundaries, system interfaces, and functional description of the HLW-RLD system are provided in Section 2.

1.2 Limitations and Scope

The scope of this document is to provide an authoritative source for the collected set of requirements applicable to the HLW-RLD system, inclusive of interface requirements with other systems. This SDD is prepared in accordance with *24590-WTP-3DP-G04B-00093, System and Facility Design Descriptions.* The intended use of these collected requirements is to provide the following:

- Inform the HLW-RLD system design effort
- Provide a validated basis upon which to confirm implementation of design requirements
- Provide the expected means of verification for requirements, including those that are post-construction (i.e., startup and commissioning test objectives and acceptance criteria)

All requirements established in this document are intended to be verified, to be implemented in design, and/or physical configuration using a graded approach commensurate with importance and risk. Alternate means of verification may be used as documented and concurred by System Engineering in the requirements verification matrix.

Where numeric values are provided within requirements in Section 3, these values are provided without additional margin. For example, if a value is established in 24590-WTP-DB-ENG-01-001, *Basis of Design* (BOD), no attempt is made to remove any margin that may or may not have gone into establishing that value, and nor has any margin been added. Where values are stated as minimums or maximums, there is no expectation that any additional margin be applied in the verifications that the design requirements have been met. Testing that is required to be performed in accordance with external codes and standards must follow the rules established in those documents.

This document is intended to be used in support of design development, design verification, turnover, startup testing, and commissioning activities. This document will be maintained current relative to changes to source requirements documents. Updates shall be made concurrent with changes to source requirements, or implementation shall be tracked for completion in accordance with 24590-WTP-GPG-ENG-0170, *Impact Evaluation.*

Engineers are expected to use the requirements in Section 3 of this document (applies only to numerical revisions of this document) as input for design development without recourse to the upper-tier source documents or searches of the Technical Requirements Management System supported by Technical Requirements Search Application. Design engineers are still required to ensure that requirements with the discipline and functional standards incorporated by reference in Section 3 are followed. These documents contain additional criteria that are based on applications of external codes and standards, corporate best practices, and engineering management expectations for a consistent approach to design.

Certain requirement statements in this document may be preceded by a "[HOLD]" notation. This notation is used when there are unresolved technical issues, known inconsistencies among source requirements, or other management suspensions of work requiring resolution. Requirements with the "[HOLD]" notation may be used to proceed with preliminary committed design but shall not be used in support of fabrication or construction until the "[HOLD]" is removed.

1.3 Ownership and Maintenance

The Design Authority (DA) organization is responsible for preparation and maintenance of this document through turnover of the included systems to Operations. Thereafter, maintenance of this document is the responsibility of the Plant Engineering organization; however, the Engineering DA organization retains responsibility for the establishment and definition of design requirements.

1.4 Definitions/Glossary

C3 Contamination Area. C3 areas are the process areas where the potential for direct contact with radioactive material, contaminated systems and components—or both—exists.

C5 Airborne Radioactivity Area. C5 areas are highly contaminated areas that require total enclosure to ensure contamination control.

Confinement. Confinement is used in this document to denote the controls used to prevent or minimize the release or migration of airborne contaminants, including aerosols, hazardous vapors, or gases.

Containment. Containment is used in this document to denote the controls used to prevent or minimize the release or migration of liquid or liquid-entrained contaminants.

Primary confinement/containment. The structures, systems, or components (SSC) and their associated boundaries that confine or contain airborne and liquid contaminants under normal conditions.

Secondary confinement/containment. The structures or other design features that capture and prevent further spread or migration of airborne or liquid contaminants after they have escaped primary confinement/containment.

Black cells. Closed cells where access is not planned during facility operation or scheduled shutdown periods. In black cells, inspection, maintenance, repair, or replacement of equipment or components is impracticable because no engineered access openings are provided for any of those purposes. The room numbers of the black cells located in the HLW Facility are H-B005, H-B014, and H-B021.

Black cell piping. All piping and tubing within the black cell up to the first weld outside the black cell. [BOD]

Hard-to-reach areas. HLW Facility areas located in the following rooms where piping and equipment are not designed for manual or remote access, replacement, or repair. [BOD]

- H-B005A, H-B032, H-B015, HCH14, HCH15, and H-0104 (components out of reach of crane and below filter deck)
- H-0115, H-0121, and H-0136 (components out of reach of crane or below canister racks or weld table)
- H-0302
- H-0308

Hard-to-reach components. Components that are not designed for manual or remote access, replacement, or repair. Hard-to-reach piping extends out to the first accessible weld. [BOD]

Passive components. Components with no moving parts, such as piping and vessels. [BOD]

Components with no active parts. Components that perform an active function, but do so with no moving parts, such as pulse jet mixers (PJM), reverse flow diverter (RFD) pumps, and steam ejectors. [BOD]

1.5 Acronyms and System Designators

1.5.1 Acronyms

A	analysis
ALARA	as low as reasonably achievable
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BOD	Basis of Design
COM	commissioning
CON	construction
DA	Design Authority
D&D	Decontamination and decommissioning
DOE	US Department of Energy
DVR	design verification report
ENG	Engineering
EQ	Equipment Qualification
EQD	Equipment Qualification Datasheet
EQP	Equipment Qualification Package

GTC	general test criteria
HEME	high efficiency mist eliminator
HLW	High-Level Waste (Facility)
HLW-RLD	high-level waste radioactive liquid waste disposal system
HPAV	hydrogen in pipes and ancillary vessels
HVAC	heating, ventilation, and air conditioning
I	inspection
ICN	integrated control network
IHLW	immobilized high-level waste (vitrified and canistered waste form)
I/O	Input/output
LAW	Low-Activity Waste (Facility)
MOB	multiple overblow
MTG	metric tons of glass
NDE	Nondestructive Examination
ORD	Operations Requirements Document
PAM	post accident monitoring
PDSA	preliminary documented safety analysis
PJM	pulse jet mixer
PT	Pretreatment (Facility)
R	review
RCRA	Resource Conservation and Recovery Act
REC	receiving
RFD	reverse flow diverter
RGM	revised ground motion
R&D	Research and Development
SBS	submerged bed scrubbers
SDD	system design description
SHR	Sodium hydroxide reagent system
SQR	supplier quality representative
SU	startup
SUB	subcontractor
SUP	supplier
SSC	structures, systems, or components
T	test
TAC	test acceptance criteria
WAC	Washington (State) Administrative Code
WPC	wet process cell
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1.5.2 System Designators

ASX	autosampling system
DIW	demineralized water system
HCP	high-level waste concentrate receipt process system
HDH	HLW canister decontamination handling system
HFP	HLW melter feed process system
HOP	HLW melter offgas processing system
HPS	high-pressure steam system
HSH	HLW melter cave support handling system
ISA	instrument service air system
LVE	low voltage electrical system (480V and below)
NAR	nitric acid reagent system
NLD	non-radioactive liquid waste disposal system
PCW	plant cooling water system
PPJ	programmable protection system
PCJ	process control system
PJV	pulse jet ventilation system
PVV	process vessel vent exhaust system
PWD	plant wash and disposal system
RLD	radioactive liquid waste disposal system

2 General Overview

The functional purpose of the HLW-RLD system is to handle and condition liquid waste for interim storage before transferring the effluents to the Pretreatment (PT) Facility plant wash and disposal system (PWD) for processing and final disposition.

The HLW-RLD system receives radioactive effluents from the HOP, the HDH, the HSH, out-of-specification streams from NLD, radioactively contaminated blowdown from PCW, and periodic plant and vessel washes within the HLW Facility. Various operations such as neutralization, mixing, and sampling of the effluent are performed by the system as required. The effluents are periodically transferred to the PT Facility's PWD, where the waste is recycled into the process or transferred to the Liquid Effluent Retention Facility/Effluent Treatment Facility for final treatment and disposal.

The HLW-RLD system includes vessels, piping, pumps, ejectors and instrumentation. The vessels include the acidic waste vessel (RLD-VSL-00007), the plant wash and drains vessel (RLD-VSL-00008), and the offgas drains collection vessel (RLD-VSL-00002). The major components (i.e., RLD vessels) of the HLW-RLD system are located in room H-B014 (black cell), which is in the center of the HLW Facility. Sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) and associated piping and valves are located in bulges (RLD-BULGE-00008 and RLD-BULGE-00009) to provide accessibility for maintenance and repairs.

Figure 2-1 provides a contextual depiction of the HLW-RLD system that highlight the flow path of the process effluent and the interrelationships with other systems and utilities. Blue arrows are used in these figures to highlight the flow path of the process effluent and the black arrows illustrate the supporting systems and utilities. The diagram does not differentiate among some utilities that have both normal and safety service provision. The diagram is used in support of functional and performance definition at the system level.

Figure 2-2 is a simplified process flow diagram of the overall HLW-RLD system. See Section 1.5 for the list of relevant system designators.

Figure 2-1 HLW-Radioactive Liquid Waste Disposal System Context Diagram

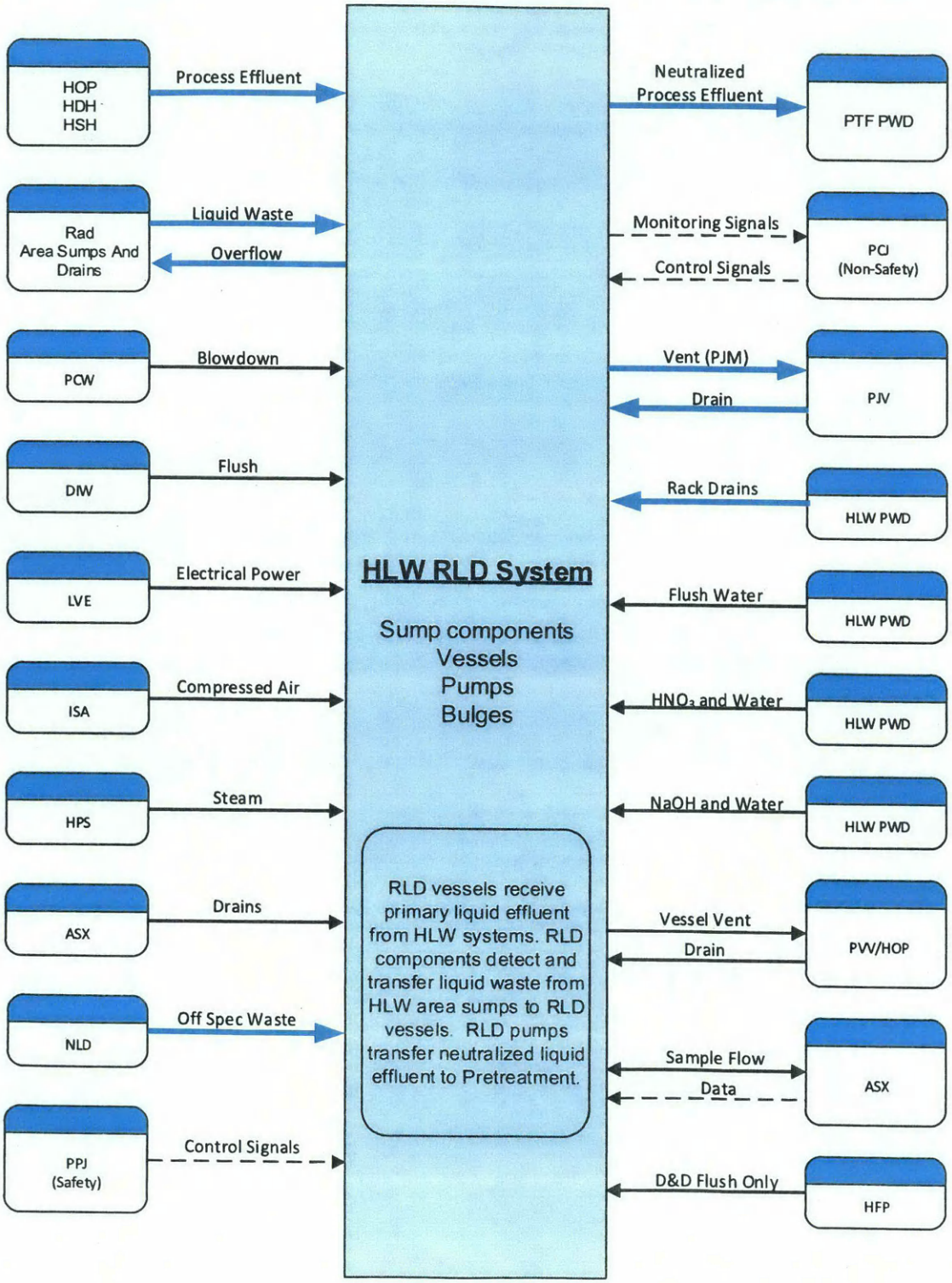
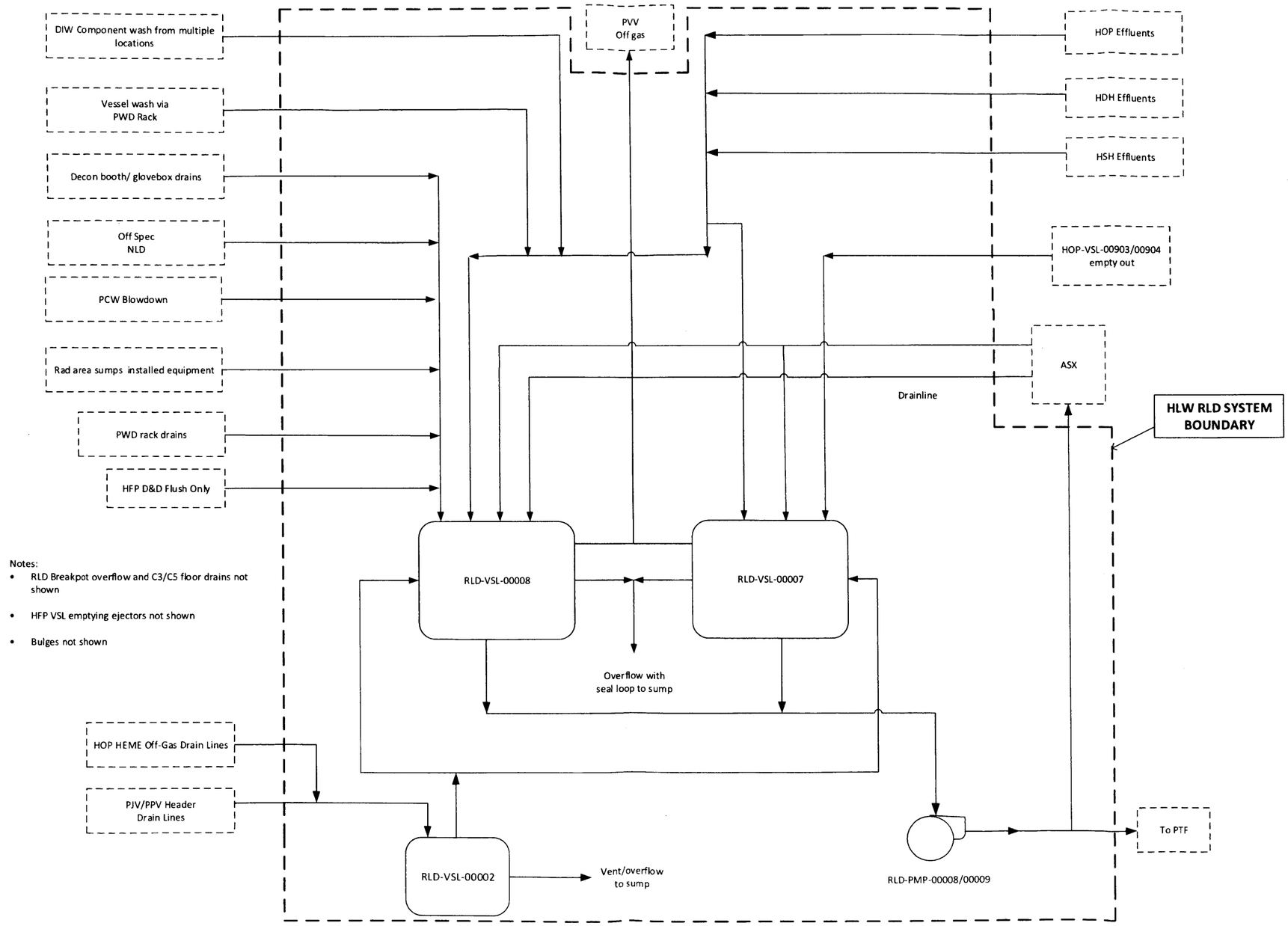


Figure 2-2 HLW-Radioactive Liquid Waste Disposal Simplified System Diagram



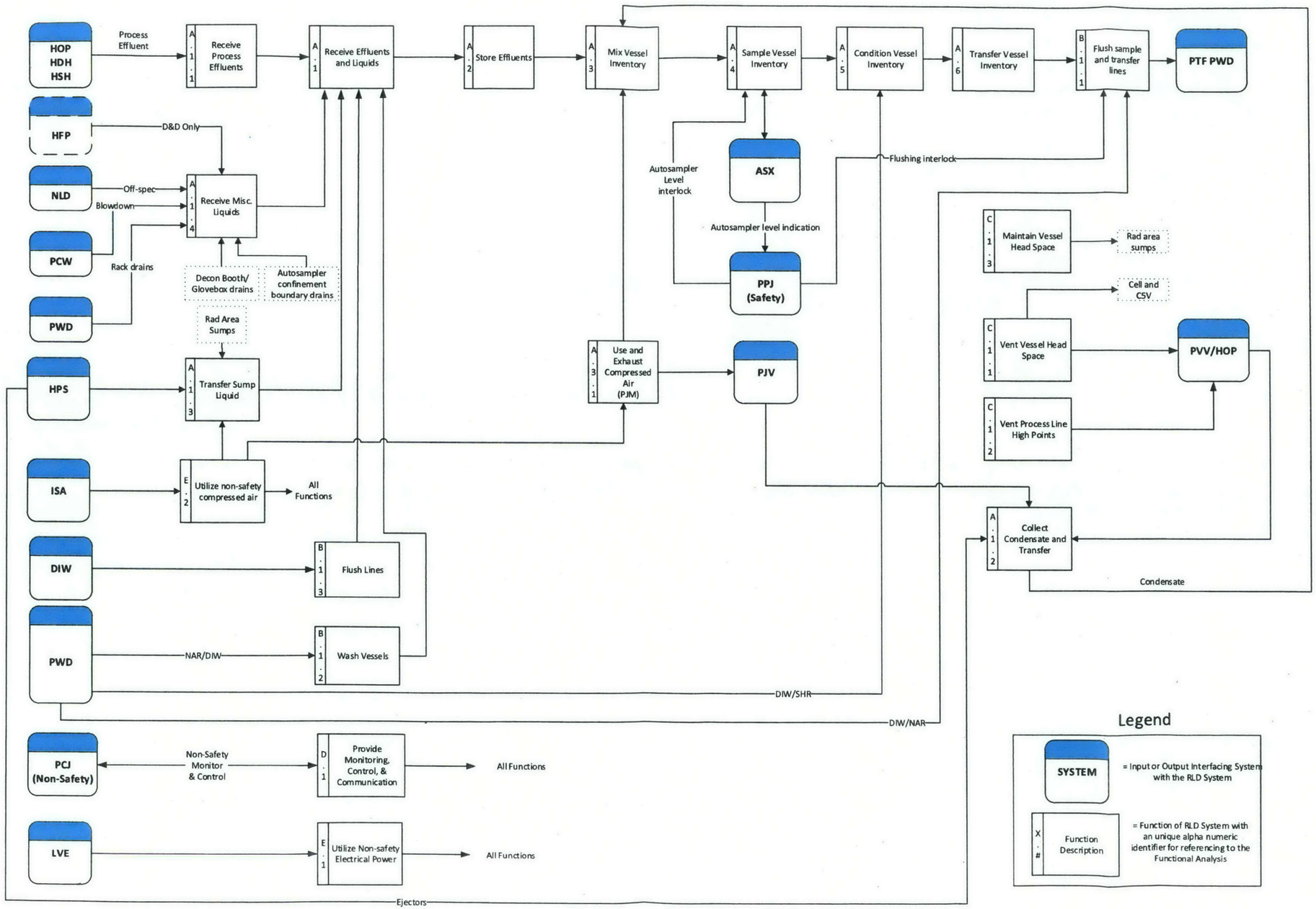
2.1 System Functions/Safety Functions

This section defines the HLW-RLD functions and attributes that need to be addressed by the system design. Figure 2-3 provides the functional block diagram for the HLW-RLD, indicating the internal and external systems and utilities that provide the primary support or interface for that function. Section 3 provides the design and performance requirements to meet both functional and other requirements.

System interfaces are provided for reference only. Except where a level of interface with the system needs to be defined, no attempt is made in this document to define functions, performance, or design requirements for interfacing systems or the facility. See Section 1.5 for the list of relevant system designators.

HLW-RLD system equipment reduces the probability of a radioactive material release by providing containment.

Figure 2-3 HLW-Radioactive Liquid Waste Disposal System Functional Block Diagram



The functions included in Figure 2-3 are the primary and secondary level functions of the HLW-RLD system, which are further described in Table 2-1. Figure 2-3 is not intended to show all functional blocks described in Table 2-1. Where appropriate to support definition of functional and design requirements, functions have been further decomposed and additional levels of supporting functions are described. The requirement section number provides the location of the applicable functions analysis incorporated into system requirements.

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
A.	**Receive, process, and transfer effluents and liquids**	N/A
A.1	Receive effluents and liquids – All radioactive process effluents and miscellaneous liquids generated during production of high-level waste glass are collected in RLD vessels RLD-VSL-00007, RLD-VSL-00008, and RLD-VSL-00002.	3.4.1.1.1, 3.5.1.2, 3.5.1.3, 3.5.1.4
A.1.1	Receive process effluents.	3.5.1.2, 3.5.1.3, 3.5.3.1.1, 3.5.3.1.2, 3.5.3.5, 3.5.3.6
A.1.2	Collect and transfer offgas condensate – The continuous function of RLD-VSL-00002 is to collect radioactive condensate from the PVV and HOP offgas and the PJV offgas drain lines. The condensate is routinely transferred using steam ejectors to RLD vessels RLD-VSL-00007 or RLD-VSL-00008.	3.5.1.4, 3.5.3.1.3, 3.5.3.2, 3.7.3.1, 3.8.3.3
A.1.3	Transfer liquid from C3/C5 area sumps to RLD vessels RLD-VSL-00007/8.	3.5.3.12
A.1.4	Receive miscellaneous liquids. • Receive off-spec NLD effluent in RLD vessel RLD-VSL-00008. • Receive heel flush transfers from the HFP vessels in RLD vessel RLD-VSL-00008 during decontamination and decommissioning. • Receive blowdown from plant cooling water system (PCW) cooling loops. • Receive drains from the PWD racks.	3.5.1.3, 3.5.3.7.1, 3.5.3.10, 3.5.3.11
A.1.4.1	Receive liquids from the decon booth or glove box to vessel RLD-VSL-00008	3.5.3.13
A.1.4.2	Receive liquids from the autosampler ASX-SMPLR-00028 confinement boundary drains.	
A.2	Store effluents – Effluents received in RLD vessels RLD-VSL-00007 and RLD-VSL-00008 are temporarily stored until the inventory is sufficient to warrant conditioning and transfer to the PT Facility.	3.5.1.2, 3.5.1.3
A.3	Mix vessel inventory – Mixing of the vessel inventory is performed to suspend insoluble solids and to blend liquids.	N/A
A.3.1	Use and exhaust compressed air (PJM) - Instrument air from the ISA system is used to power the jet pump pairs that control the PJMs used for mixing vessel inventory.	3.8.3.2
A.3.2	Mixing of the vessel inventory is routine prior to/and during sampling, conditioning, and transfer of the inventory to the PT Facility.	3.8.1.1, 3.8.1.2.1
A.4	Sample vessel inventory – The RLD vessel inventory is circulated through an auto sampler (ASX-SAMPLR-00028), which extracts a sample to the ASX system for analysis in the Analytical Laboratory. Transfers to the autosampler are performed by the RLD sample transfer	3.5.3.15, 3.9.2.2

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
	pumps. A safety high level signal from the autosampler initiates a pump stop signal to the sample/transfer pumps.	
A.5	Condition vessel inventory – These functions involve addition of sodium hydroxide, vessel cooling, and makeup water to RLD-VSL-00007 and RLD-VSL-00008.	N/A
A.5.1	Sample data or process knowledge is used to determine the quantity of sodium hydroxide reagent required to neutralize the inventory and to increase the solution pH.	3.5.3.8.1
A.5.2	Demineralized water (makeup) is added via the PWD rack to the vessels to maintain a hydraulic seal.	3.5.3.9
A.6	Transfer vessel inventory – Conditioned effluent is batch transferred to the PT Facility for processing.	3.5.3.14
B.	**Flush/Wash Components**	N/A
B.1	Flush system – Flushing is necessary to ensure system performance.	N/A
B.1.1	Flush sample and transfer lines following each use to remove solids from the lines. Demineralized water and nitric acid reagent flush volume are supplied from the PWD rack. A safety interlock prevents sample/transfer pump operation if the system is aligned for flushing activities.	3.6.3.1, 3.9.2.3
B.1.2	Wash RLD vessels RLD-VSL-00007 and RLD-VS-00008 with demineralized water as necessary to remove heel liquid and solids. DIW wash volume and NAR for decontamination are supplied from the PWD rack.	3.5.3.8.2, 3.5.4.1
B.1.3	Flush and wash system components as required to keep radiation exposure as low as reasonably achievable (ALARA) for maintenance. Flush water is supplied directly from the DIW distribution header.	3.6.3.1
B.1.3.1	Flush transfer lines from RLD-VSL-00007 and RLD-VSL-00008 to PWD-VSL-00033 and PWD-VSL-00043.	3.6.3.1
B.1.3.2	Flush sample/return lines.	3.6.3.1
B.1.3.3	Flush RLD-VSL-00007 and RLD-VSL-00008 recirculation lines from RLD sample and transfer pumps.	3.6.3.1
B.1.3.4	Flush PJMs drive piping.	3.8.3.1
B.1.3.5	Flush level detection bubbler lines in RLD-VSL-00007 and RLD-VSL-00008.	3.6.3.1
C.	**Provide Vent and Overflow**	N/A
C.1.1	Vent vessel headspace.	N/A
C.1.1.1	Vent RLD vessel RLD-VSL-00007 and RLD-VSL-00008 headspaces to the process vessel vent exhaust system (PVV).	3.5.3.3
C.1.1.2	Vent RLD vessel RLD-VSL-00002 headspace to the C5 ventilation via the overflow.	3.5.3.4
C.1.2	Vent process line high points to the PVV for hydrogen mitigation.	3.6.1.1.1, 3.6.3.2
C.1.3	Maintain vessel headspace by providing an overflow path.	N/A
C.1.3.1	RLD vessel RLD-VSL-00002 overflows to the RLD-SUMP-00001.	3.5.1.5

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
C.1.3.2	RLD vessels RLD-VSL-00007 and RLD-VSL-00008 overflow to the HCP-SUMP-00001 via a seal loop to prevent the PVV/HOP system from being overwhelmed by the inflow of air through an open overflow line.	3.4.4.1, 3.5.1.5
D.	**Provide monitoring, control, and communication functions**	N/A
D.1	Non-Safety Monitoring, control, and communications – PCJ provides non-safety monitoring and control functions.	N/A
D.1.1	Monitor pressure	3.5.1.1.3, 3.9.1.1.1
D.1.2	Monitor liquid level	3.4.1.1.2, 3.9.1.1.1, 3.9.1.2.1, 3.9.2.1, 3.9.1.3.3
D.1.3	Monitor temperature	3.9.1.1.1, 3.9.1.3.1, 3.9.1.3.2
D.1.4	Process control through trips and interlocks via monitoring internal conditions in vessels, sumps, and associated piping	3.9.1.1.2, 3.9.1.1.5, 3.9.1.2.2, 3.9.1.2.3, 3.9.1.2.4, 3.9.1.3.2, 3.9.2.2, 3.9.2.3
E.	**Utilize External Services**	N/A
E.1	Utilize non-safety electrical power – The low voltage electrical (480/208/120 V) system (LVE) provides electrical power to the RLD equipment and instruments.	3.4.3.2
E.2	Utilize non-safety compressed air –Instrument air from the ISA system is used to provide motive power for remotely actuated valves, bubbler instrumentation, purge air for the RLD-VSL-00007 and RLD-VSL-00008 overflow lines, and for purging steam ejector lines via the steam racks.	3.4.3.1

2.2 System Classification

The HLW-RLD contains components with the following classifications/designations:

- ☐ Safety Class
- ☒ Safety Significant
- ☒ Dangerous Waste Permit affecting
- ☒ Air Permit affecting
- ☐ Waste Acceptance Impacting
- ☒ General

2.3 Basic Operational Overview

A functional description of the HLW-RLD is provided in Sections 2 and 2.1, which provide the context diagram for the system, interfaces with other systems, a simplified systems diagram, a functional block diagram, and descriptions of the system functions. A basic operational overview of the system is described in this section. Detailed operational information is in Section 4.

The HLW-RLD system is located in the HLW Facility of the Hanford Tank Waste Treatment and Immobilization Plant (WTP). The HLW-RLD system receives radioactive effluents from the HOP, the HDH, the HSH, out-of-

specification streams from NLD, radioactively contaminated blowdown from PCW, and periodic plant and vessel washes within the HLW Facility. The effluents collected by the HLW-RLD system are stored in RLD vessels. The vessels include the acidic waste vessel (RLD-VSL-00007), the plant wash and drains vessel (RLD-VSL-00008), and the offgas drains collection vessel (RLD-VSL-00002). Various operations such as neutralization, mixing, and sampling of the effluent are performed by the system as required. The effluents are periodically transferred to the PT Facility's PWD, where the waste is recycled into the process or transferred to the Liquid Effluent Retention Facility/Effluent Treatment Facility for final treatment and disposal.

3 Design Requirements

3.1 Requirements

Requirements are documented in Sections 3.4 through 3.9. Each requirement statement is accompanied by a basis discussion (as needed) and the expected means of verification. If a design cannot meet a requirement stated in this document, a revision to the requirement needs to be pursued or the design must be changed to meet the requirement.

Requirements preceded by "**[HOLD]**" may only be used in support of preliminary or committed design, which shall also be issued with appropriate holds per 24590-WTP-3DP-G04B-00046, *Engineering Drawings*. These requirements may not be used in support of fabrication or construction.

The following abbreviations are used to designate the selected method for verification (see 24590-WTP-3DP-G04B-00092, *System Verification*, for additional guidance concerning methods of verification):

(A) Analysis
(R) Review
(I) Inspection
(T) Test

The following abbreviations are used to designate the organization responsible for performing the verification:

(ENG) Engineering
(CON) Construction
(SU) Startup
(COM) Commissioning
(SUP) Supplier
(SUB) Subcontractor
(SQR) Supplier quality representative
(REC) Receiving

3.2 Bases

Basis discussions are provided as needed to explain the decomposition or interpretation from the originating source requirement (s). Where included, basis discussions provide supplementary information to help the reader understand the origin or intent of a requirement. Basis statements do not include requirements and are not

considered requirements. Where a **HOLD** has been applied to a requirement, this section will include the basis for the HOLD.

3.3 References

The requirements include a source document reference. Each unique source document reference is bracketed separately. Requirements may include a reference to the Section 2.1, Functional Description, listed in parentheses following the source document. A complete listing of all source references is provided in Section 5.

A complete listing of all source references is in Section 5.1.

3.4 General Requirements

3.4.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.4.1.1 Throughput (Design Capacity)

Requirement: The HLW-RLD system shall be designed with sufficient capacity to support 7.5 MTG/day production. (A.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify that HLW-RLD receipt, storage and transfer capacities support the required HLW Facility designed throughput.	
R	ENG	Review design to verify conformance to the analysis.	May be documented in an assessment/evaluation.

3.4.1.1.1 Volume of Collected Effluents, Normal Operating Conditions

Requirement: The HLW-RLD shall be capable of receiving the volumes of effluent from the HOP, the HDH, the HSH, out-of-specification streams from NLD, radioactively contaminated blowdown from PCW, sample line flushes from ASX-SMPLR-00028, and periodic plant and vessel washes within the HLW Facility. (A.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify that the RLD vessels have been sized to accept the required waste transfers.	
R	ENG	Review design to verify conformance with analysis and that the HLW-RLD vessels receive effluent from the HOP, the HDH, the HSH, out-of-specification streams from NLD, radioactively contaminated blowdown from PCW, and periodic plant and vessel washes within the HLW Facility.	

3.4.1.1.2 Transfer Volume Balances

Requirement: The HLW-RLD system shall have the capability to determine volume balances during transfers to or from the acidic waste vessel, the plant wash and drains vessel, or the offgas drains collection vessel. [Section 7.1, ORD] (D.1.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that the HLW-RLD has the capability to measure volume balances during transfer.	
T	SU/COM	Verify the capability to determine volume balance during transfers to the acidic waste vessel, and the plant wash and drains vessel.	

3.4.1.2 Design Life

3.4.1.2.1 Design (Operating) Life

Requirement: Nonreplaceable, permanent HLW-RLD system plant equipment listed in Table 3-1 shall be designed for a minimum design life of 40 years, inclusive of maintenance. All nonmaintainable items of HLW-RLD system equipment shall be designed to last the life of the facility (40 years). Design life of equipment shall consider the effects of chemical, radiological and thermal exposure. [Section C.7, paragraph (a)(1), Hanford Tank Waste Treatment and Immobilization Plant (WTP) Contract No. DE-AC27-01RV14136, [ID: DE-AC27-01RV14136 Section C] [Section 11.1.1, 11.7.4, 12.3.1.1, 14.1 16.4.1.1, 16.4.2.2, BOD] [Section 14.1, ORD]

Table 3-1 HLW-Radioactive Liquid Waste Disposal System Equipment and Components Design Life

Equipment/Component Description	Design Life (Years)
Plant wash and drains vessel	40
Acidic waste vessel	40
Offgas drains collection vessel	40
Pulse jet mixers	40
Jet pump pairs	40
Steam ejectors	40
HLW-RLD piping and jumpers	40
Breakpots	40

Basis Discussion: Equipment and material selection is based on proven performance, value engineering principles, and fit-for-function principles. The selection of equipment and materials is further addressed in detail as the design progresses. Equipment design needs to consider the routine environmental exposures under normal operations for non-safety equipment; safety and post accident monitoring (PAM) equipment also considers

abnormal and emergency exposures — this minimizes the need for equipment maintenance, exposure, and radiological waste generation in radiological areas.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	The "qualified" design life for safety SSCs is to be verified through equipment environmental qualification documentation that may be accomplished through analysis or testing.	Design life for safety and PAM equipment to be documented in equipment qualification packages
R	ENG	Review design to verify design life of non-replaceable, non-maintainable SSCs is documented in procurement documents and supported by supplier certificates of conformance.	May be documented in an assessment/evaluation.

3.4.1.2.2 Materials of Construction and Erosion/Corrosion Design Parameters

Requirement: The HLW-RLD system equipment and components shall include allowance for erosion/corrosion and use materials of construction for the fluid service conditions in order to meet the life expectancy that is identified in Section 3.4.1.2.1 of this SDD. [Safety Criterion 4.2-3, Appendix H Section 4, SRD] [Sections 9.1, 11.16, 14.16, 20.0, ORD] [Sections 6.7.4, 9.1, 11.4.1, 11.9, 14.10.1, 16.4.1.1, 16.4.1.4, BOD] [Section III.10.E.9.c.v, DWP WA7890008967]

Basis Discussion: The allowance for erosion/corrosion and applicable materials of construction are limited to those components that come into contact with the process fluids and that are required to maintain confinement/containment of those process fluids. Materials of construction that can withstand the erosive/corrosive waste effluents and chemicals are selected. The materials for the HLW-RLD system equipment and components should be selected based on the stream data presented in the process corrosion data sheet report. If vessel washing via internal spray mechanisms is needed to prevent or minimize corrosion, the operational limitation is identified in the vessel corrosion evaluation. Fluid characteristics of the process streams to be used for corrosion evaluation are described in 24590-WTP-RPT-PR-04-0001-01 through 24590-WTP-RPT-PR-04-0001-06, *WTP Process Corrosion Data*, volumes 1-6.

Details of the allowed materials and corrosion allowances can be found in:

- 24590-HLW-N1D-RLD-00001, RLD-VSL-00007 (HLW) - Acidic Waste Vessel
- 24590-HLW-N1D-RLD-00002, RLD-BRKPT-00007 & RLD-BRKPT-00009 - (HLW) Acidic Wash Transfer Breakpot - Corrosion Evaluation
- 24590-HLW-N1D-RLD-00006, RLD-VSL-00008 (HLW) - Plant Wash and Drains Vessel
- 24590-HLW-N1D-RLD-00009, RLD-BRKPT-00004 (HLW) - Wash Effluent Breakpot
- 24590-HLW-N1D-RLD-00013, RLD-VSL-00002 (HLW) - Offgas Drains Collection Vessel

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Perform an analysis/inspection of materials used in the HLW-RLD system which are in contact with, and are required to maintain containment of the process fluids, to verify that they are acceptable for use in the operating environment and have adequate erosion and corrosion allowances.	
R	ENG	Review design components used in the HLW-RLD system which are in contact with, and are required to maintain containment of the process fluids, for concurrence with analysis.	

3.4.1.2.3 Nonmaintainable Soft or Nonmetallic Parts

Requirement: The HLW-RLD system equipment and components located in black cells and hard-to-reach areas shall be designed with no nonremovable soft or nonmetallic parts that could be affected by the total integrated radiation dose, including gamma and beta. [Section 16.4.1.1, BOD] [Section 20, ORD]

Basis Discussion: Soft or nonmetallic parts can be affected by radiation and lose their capability to perform in this environment.

This is an ALARA impacting requirement because if components fail, they will have to be replaced and may result in dose to personnel or contamination issues.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the total integrated radiation dose (including gamma and beta) to nonremovable soft or nonmetallic parts within black cells and hard-to-reach areas.	
R	ENG	Review the following: - Review design to verify that the total integrated dose input is in conformance with the analysis - Review equipment datasheets to confirm design requirements for non-safety equipment are documented - Review supplier-provided certified material test reports or equivalent (i.e., soft parts that provide a containment or confinement boundary).	May be documented in an assessment/evaluation.

3.4.1.2.4 Room Environment Conditions for Non-safety SSCs

Requirement: The HLW-RLD non-safety equipment and components shall be designed to operate and withstand the internal environment conditions of the HLW Facility. [Section 12, Table 12-1, BOD] Section 11.16, 14.8, 14.15, 16.1, ORD]

Basis Discussion: Non-safety structures, systems and components (SSC) are designed to function as intended in the room environment conditions associated with their location.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design of non-safety SSCs to verify compliance with BOD Table 12-1 conditions.	

3.4.1.2.5 Room Environment Conditions for Safety SSCs

Requirement. The safety SSCs in the HLW-RLD system credited with a safety function and post accident monitoring instruments (24590-HLW-RPT-ENS-12-002, HLW Preliminary Post Accident Monitoring Report) shall be designed to operate and withstand the most severe environmental conditions identified for the room in which they are installed, inclusive of aging effects throughout their qualified life. [Safety Criterion 4.1-3, Safety Criterion 4.4-1, SRD] [Section 11.7.3, BOD]

Basis discussion: Safety SSCs, designated as safety class (SC) or safety significant (SS), are designed and qualified to function as intended in the room environment conditions associated with the events for which they are intended to respond. The effects of aging on normal and abnormal functioning are considered in design and qualification. HLW Room Environment Data Sheet, 24590-HLW-U0D-W16T-00001 identifies environmental conditions for rooms that house safety SSCs.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing to verify the ability of the SSCs credited with a safety function and post accident monitoring to withstand specified environmental conditions.	Document in equipment qualification package. See HLW Room Environment Data Sheet, 24590-HLW-U0D-W16T-00001, for room environment conditions.
R	ENG	Review the design to verify conformance to the as-tested or as-analyzed configuration.	Document in an evaluation/assessment or EQP

3.4.1.3 Seismic Design

Requirement: The HLW-RLD system equipment, including PAM, shall be designed and qualified for seismic conditions in accordance with Table 3-2 below:

Table 3-2 HLW-Radioactive Liquid Waste Disposal System Seismic Design Categories

Description	Seismic Category	Reference
Piping of overflow lines on manifolds that connect to C3 and C5 area sumps	SC-III	[Section 4.4.29, PDSA- HLW FACILITY]
RLD and PVV bulge confinement assembly drain lines	SC-III	[Section 4.4.31, PDSA-HLW Facility]
RLD vessels located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008)	SC-I	[Section 16.4.2.1, BOD]
RLD piping located in black cells	SC-I	[Section 16.4.2.7, BOD]

Basis Discussion: Section 2.4.12 of 24590-WTP-PSAR-ESH-01-002-01, *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information* states the following: "All components and parts of the equipment that provide or contribute to the safety functions and accident monitoring functions, including equipment supports and anchorage, shall be qualified accordingly." This qualification ensures SSCs meet the designated seismic design requirements. The SRD, Safety Criterion 4.1-3 details the equivalence of the WTP seismic category to the seismic performance category of DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*. The SRD also states that SSCs designated as safety SSCs be designed to withstand the effects of NPH events (e.g., earthquakes, wind, and floods) without loss of capability to perform specified safety functions.

Piping and vessels listed in BOD, Appendix B are allowed to be designed for the WTP Site-Specific Ground Motion (WSGM).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG/SUP	Analysis or test performed on equipment listed in Table 3-2 to demonstrate capability to withstand seismic event.	This is expected to be documented in the equipment qualification packages.
R	ENG	Review design to verify conformance to the as-tested/as-analyzed configuration.	May be accomplished by equipment qualification packages or separate assessment.

3.4.1.4 Redundancy in the HLW-Radioactive Liquid Waste Disposal System

Requirement: The HLW-RLD equipment and components located in closed cell and/or hard-to-reach areas shall have redundant capabilities as necessary to achieve a 40-year design life (see Table 3-3). [Sections 11.3.2, 11.4.2, 16.4.1.1, BOD] [Section 14.1, ORD]

Table 3-3 HLW-Radioactive Liquid Waste Disposal System Equipment/Components Redundancy

Equipment/Component Description	Redundancy Required?
PJMs	No
Centrifugal sample/transfer pumps	No
Instruments	No
Steam ejectors for HLW-RLD-VSL-00002	Yes
Steam ejectors for sumps HOP-SUMP-00003, HOP-SUMP-00008, HCP-SUMP-00001, and RLD-SUMP-00001	Yes
Manifold overflow feature	No
Transfer pipes	No

Basis Discussion: This requirement is decomposed for the BOD and 24590-WTP-RPT-OP-01-001, *Operations Requirements Document* (ORD) requirement to provide redundancy. The steam ejectors in HLW-RLD-VSL-00002 provide redundancy for discharge path transfer to either RLD-VSL-00007 or RLD-VSL-00008. The steam ejectors for the following sumps provide redundancy as follows: (1) HOP-SUMP-00003, HOP-SUMP-00008, and HCP-SUMP-00001 for transfer of effluent to HFP-VSL-00001, (2) RLD-SUMP-00001 provide redundancy for transfer of effluent to RLD-VSL-00008.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the system design for incorporation of the required redundancy features.	May be documented in an assessment/evaluation.

3.4.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.4.2.1 Safety Designations

Requirement: The HLW-RLD SSCs shall be designated as safety SSCs in accordance with Table 3-4 below:

Table 3-4 HLW-RLD system Safety Designation

Equipment/Component Description	Safety Function	Safety Designation	References Safety Classification
RLD-VSL-00007 and RLD-VSL-00008	Mitigate the consequences of the release of radioactive and chemically hazardous offgas by maintaining confinement (in support of the HOP/PVV confinement function).	SS	[Section 4.4.16.4, PDSA-HLW Facility]
RLD-VSL-00007 and RLD-VSL-00008 interfacing SSCs that perform confinement boundary functions.	Mitigate the consequences of the release of radioactive and chemically hazardous offgas by maintaining confinement (in support of the HOP/PVV confinement function).	SS	[Section 4.4.16.4, PDSA-HLW Facility]
Overflow lines on manifolds that connect to C3 and C5 area sumps	Provision of an overflow line reduces the probability of an internal/external dose to facility worker by preventing backflow to C3 areas from C5 areas in the event of a transfer line blockage to the RLD vessel downstream of the manifold.	SS	[Section 4.4.29, PDSA-HLW Facility]
RLD and PVV bulge confinement assembly drain lines	Mitigates the consequence of a release of radioactive and chemically hazardous material by providing confinement and shielding (confinement boundary includes drain).	SS	[Section 4.4.31, PDSA-HLW Facility]
RLD transfer pump (remotely actuated) flushing supply valves	Reduce the probability of direct radiation exposure to the facility worker (flush interlock with sampling pumps). Valve position indication initiates interlock.	SS	[Section 4.4.19, PDSA – HLW Facility]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify that the safety designation and function, as established in the PDSA/DSA, are correctly reflected in the equipment qualification datasheet and supporting document in the equipment qualification package.	May be accomplished by EQP and/or Design Verification Report (DVR) to align with the PDSA/Documented Safety Analysis.

3.4.2.2 DWP Secondary Containment Requirements – Ancillary Equipment

Requirement: The HLW-RLD ancillary equipment located in plant areas that do not provide secondary containment (as documented in 24590-HLW-RPT-ENV-09-001, Dangerous Waste Permit Secondary Containment Requirements for HLW Facility) shall be provided with secondary containment (e.g., coaxial piping). [Section 14.10.1.3, BOD]

Basis Discussion: Secondary containment design requirements are specified in 24590-HLW-RPT-ENV-09-001, *Dangerous Waste Permit Secondary Containment Requirements for HLW Facility* and 24590-HLW-3ZD-30-00001, *HLW Facility Design Description.*

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to ensure secondary containment is provided in conformance with 24590-HLW-RPT-ENV-09-001.	May be documented in an evaluation/assessment. Environmental group to participate in or review evaluation/assessment.

3.4.3 System Interface Requirements

The effluent sources interfacing with the HLW-RLD are from the HLW Facility C3/C5 sumps, the waste neutralization vessel (HDH-VSL-00003), the decontamination tank melter cave 1 and 2 (HSH-TK-00001/00002), and submerged bed scrubbers (HOP-SCB-00001/00002). The system also receives drains from HOP high efficiency mist eliminator (HEME) offgas, PCW system cooling loops blowdown, decon booth/glove box, pulse jet ventilation (PJV) system header drain lines, and PCW drains. The boundary limits of the HLW-RLD are dependent on system interactions. The boundary limits with the HDH, HOP, HSH, and PJV systems start from the nozzle connections on the HLW-RLD collection vessels.

All other boundaries between the HLW-RLD and other systems are defined based on their type of control. The boundaries for controlled processes are at the control valve. Specific system interfaces are discussed in the subsequent requirement sections titled "System Interface Requirements."

3.4.3.1 Non-Safety ISA Interface

Requirement: The HLW-RLD shall receive sufficient instrument air to operate all air-operated devices expected to be operating simultaneously during normal plant operations. [Section 6.4, BOD] (E.2)

Basis Discussion: Air consumption rates and frequency for HWL-RLD air-operated devices are identified and used as input to determine ISA system capacity. Instrument air temperature and dew point requirements are covered under the ISA SDD.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify through collective system-level analysis that the ISA system and interfaces with HLW-RLD are designed with sufficient capacity to operate all HLW-RLD air-operated devices expected to be operating simultaneously during normal plant operations.	
R	ENG	Review design to verify conformance to the results of the analysis.	May be documented in an assessment/evaluation.

3.4.3.2 Non-Safety LVE Interface

Requirement: The HLW-RLD shall receive non-safety LVE power for operation of all components. (E.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify by analysis that the non-safety LVE system capacity supports HLW-RLD system equipment operation.	
R	ENG	Review the design to verify that non-safety SSCs are provided with power from non-safety LVE.	

3.4.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.4.4.1 Hydraulic Seals

Requirement: Hydraulic seals shall be implemented in the HLW-RLD design to prevent inflow of air into the PVV, PJV or HOP systems. (C.1.3.2)

Basis Discussion: The hydraulic seals are needed to prevent inflow of air into the PVV, PJV, or HOP systems.

For proper operation, hydraulic seals will be filled during startup operations. The HLW RLD-VSL-00002 will be filled with DIW via PWD-RK-00032 until the PJV drain line, offgas drain lines, and dipped overflow line are all submerged to provide a pressure boundary between the offgas ventilation systems (PJV and HOP offgas) and the black cell (room H-B014).

The overflow loop seal between HLW RLD-VSL-00007, RLD-VSL-00008, and HCP-SUMP-00001 will be filled with DIW via PWD-RK-00032 with sufficient water to form a hydraulic seal to prevent black cell air from entering the vessels' headspace. The overflow loop seal is equipped with level instrumentation. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that hydraulic seals are included in the design.	

3.4.4.2 Provision for Extra Nozzles, Branches, or Spools

Requirement: The design shall accommodate provisions as necessary to support startup and commissioning testing. [Section 11.4.7, BOD] [Section 19.12, ORD]

Basis Discussion: Additional nozzles, branch lines, removable spools or other provisions that may be needed to support identified testing are to be accommodated in the design as jointly determined by the design agency, startup and commissioning during the design development and review process, with consideration given to the tests and demonstration activities required for requirement verification specified in Appendix A. This may include, but is not limited to, provisions to support the introduction or removal of fluids, gases, reagents, or simulants; or the availability of special test ports, sampling ports, or temporary instruments or instrument lines.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify requirement is met based on established tests/demonstrations to be performed during startup and commissioning. Perform an assessment to document the review.	Startup and commissioning to participate in assessment led by design agency.

3.4.4.3 Isolation and Test Points

Requirement: Isolation and test points with drain/bleed valves shall be included in the HLW-RLD design to allow for testing of plant items during normal operations and removal or replacement as applicable. [Section 11.5.1, BOD] [Sections 9.1, 14.13, 19.12, ORD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review applicable HLW-RLD P&IDs to verify that isolation and test points with drain/bleed valves are included into the design to allow for testing of equipment during normal operations.	

3.4.4.4 Remotely Maintainable or Replaceable Equipment and Components

Requirement: The HLW-RLD maintainable or replaceable equipment and components (i.e., not located in black cells or hard-to-reach areas) shall be designed with remote handling features to be removed and reinstalled in accordance with Table 3-5 below or be located in accessible areas (e.g., bulges). [Sections 5.2, 7.1, 8.1.3, 9.1, 10.4, 14.1, 14.8, ORD] [Sections 9.4.2, 11.3.1, 11.3.2, 11.3.2.2, 11.4.1, 11.8.3.1, BOD]

Table 3-5 Remotely Maintainable or Replaceable Equipment and Components

Equipment/Component Description	Remotely Removable and Replaceable
Vessels RLD-VSL-00002/00007/00008	No
PJMs	No
Jet pump pairs	No

Equipment/Component Description	Remotely Removable and Replaceable
RLD sample/transfer pumps[1]	No
Jumpers	Yes
Instruments	No
Breakpots	No
Sump	No
Sump diaphragm pumps	No
Sump steam ejectors [2]	Yes
Overflow feature	No
Transfer pipes	No
Valves[1]	No

Notes:
1. Equipment located in bulges.
2. Some of the steam ejectors (RLD-EJCTR-00171, RLD-EJCTR-00172, RLD-EJCTR-00178, and RLD-EJCTR-00179) located in sumps that receive effluents from HFP and HSH have jumpers and hence are remotely maintainable. The rest of the steam ejectors are on hard-piping and are not remotely maintainable.

Basis Discussion: Maintenance operations are generally to be performed hands-on in the maintenance shop. In-cave equipment disassembly, removal to maintenance area, and/or replacement is accomplished by local remote handling equipment or by remote handling equipment in dedicated maintenance areas or caves. In general, process systems and equipment within cells or caves that could fail during operations are designed for safe recovery, replacement, or redundancy. Equipment or components requiring regular maintenance are located in accessible areas. Remote handling features are provided for equipment or components located in hard to reach areas.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Confirm using a software program that all replaceable components can be removed without interference.	Recommend using a software program such as "IGrip" (or similar)
T	**SU/COM**	Verify remotability in accordance with 24590-WTP-RACT-RT-0001, *WTP Remotability Verification Plan.*	

3.4.4.5 Remote Valve Operation

Requirement: Remote operation shall be provided for valves located where accessibility is difficult, such as R5/C5 areas, and for valves used in routine operations. Valves shall have position indication from directly coupled positioning mechanisms unless other indications are available such as flow, level, and pressure. The indication signal shall be visual, mechanical electric, or electronic based on the valve location and type of valve. [Section 14.4, ORD]

Basis Discussion: Remote operation is used to ensure that the WTP Facility design achieves occupational doses that are ALARA. Valves are equipped with position indicators and reach rods, if necessary, are designed for easy

removal and, when reinstalled, only engage the valve in the correct alignment, using no more than two universals. Valves are shown on design drawings and uniquely labeled in accordance with 24590-WTP- 3DP-G03-00044, Standard Component Numbering.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review HLW-RLD drawings to verify that remote operation is provided for valves that are located in areas where accessibility is difficult, such as C3/C5 areas.	
T	SU/COM	Verify remote valve operation to ensure system operation is as designed.	

3.4.4.5.1 Remote Valve Operation – Valve Actuator Closure Speed

Requirement: Valve actuators of HLW-RLD power-operated valves shall be designed with capability to close at speeds that prevent initiation of a water hammer event during normal operations. [Section 14.4, ORD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Determine by analysis the maximum speed at which power-operated valve actuators may close to prevent initiation of a water hammer event.	
R	ENG	Review design to verify valve actuators are designed in conformance with the analysis.	
T	SU/COM	Perform operational test to show power-operated valves closes at or below TBD in/s.	

3.4.4.6 Maintain Operability – RLD System Partial Outage

Requirement: The HLW-RLD system shall be designed to maintain the capability to collect and transfer effluents during a partial outage of the system. [Section 14.1, ORD]

Basis Discussion: The RLD system is designed with redundancy to allow maintenance of active equipment (e.g., pumps, power-operated valve actuators).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review HLW-RLD design to verify that the system maintains the capability to collect and transfer effluents during a partial outage of the system (e.g., due to maintenance).	May be documented in an assessment/evaluation.

3.4.4.7 Valve Lockout Design

Requirement: The HLW-RLD system valves shall be designed/procured, where possible, to support lockout commercially manufactured devices other than chains. [Section 7.1, ORD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review HLW-RLD design to verify valves are specified to include design provisions for lockout that do not require the use of chains, where possible.	May be documented in an assessment/evaluation.

3.5 Vessel Requirements

3.5.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.5.1.1 Vessel Design and Operating Conditions

3.5.1.1.1 Black Cell/Hard-To-Reach Nozzle Design

Requirement: Nozzles penetrating the primary confinement boundary of HLW-RLD vessels located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) shall be integrally reinforced and attached by full penetration welds. [Section 16.4.2.1, BOD]

Basis Discussion: Using additional reinforcing elements such as reinforcing rings or pads is prohibited. Reinforcing material is to be provided by excess thickness on the shell or head and nozzle neck. Additional reinforcing material may be provided, when required, by increasing the shell head or nozzle thickness, or by providing a thicker insert plate of a suitable diameter, butt welded into the shell or head. If required to accommodate occasional loads, such as the revised ground motion (RGM) accelerations, hydrogen in pipes and ancillary vessels (HPAV) loads or multiple overblow (MOB) loads, in fabricated vessels, reinforcing collars can be used.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify that the nozzles penetrating the primary confinement boundary of HLW-RLD vessels located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) are integrally reinforced and attached by full penetration welds.	May be documented in an assessment/evaluation.

3.5.1.1.2 Black Cell/Hard-To-Reach Minimum Design Pressure

Requirement: The HLW-RLD vessels located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) shall be designed to withstand the maximum negative pressure generated by the HLW melter offgas treatment process system (HOP) and a minimum design pressure of 15 psig. [Section 16.4.2.1, BOD] (D.1.1)

Basis Discussion: The HLW-RLD vessels are designed to withstand the maximum negative pressure vacuum created by the HLW-HOP booster and stack fans.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the maximum negative pressure generated by the HOP system and verify the RLD vessel design can withstand it.	
R	ENG	Review of design to verify that HLW-RLD vessels located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) are designed to withstand the maximum negative pressure generated by the HOP system and a minimum design pressure of 15 psig.	Documented in DVR.

3.5.1.1.3 Black Cell/Hard-To-Reach Fatigue Analysis - Vessels

Requirement: The design of HLW-RLD vessels (including internal components) located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) shall include fatigue analyses in accordance with the ASME Section VIII, Division 1, Paragraph UG-22(e) and ASME Section VIII, Division 2, Paragraph AD-160 and Appendices 4 and 5, as required, to ensure that they will maintain integrity for the number of expected cycles during operation over a design life of 40 years. [Section 16.4.2.3, BOD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform fatigue analyses on HLW-RLD vessels (including internal components) located in black cells or hard-to-reach areas (e.g., RLD-VSL-00002, -00007, -00008, RLD-BRKPT-00004, -00007, -00009) in accordance with the ASME Section VIII, Division 1, Paragraph UG-22(e) and ASME Section VIII, Division 2, Paragraph AD-160 and Appendices 4 and 5, as required.	
R	ENG	Review of design to verify performance of fatigue analyses per code requirements.	May be documented in an assessment/evaluation.

3.5.1.2 Capacity of Vessel HLW-RLD-VSL-00007

Requirement: The HLW-RLD vessel RLD-VSL-00007 shall be sized to accommodate the required effluent inflows; the vessel maximum capacity shall conform to the stated maximum capacities in the Dangerous Waste Permit (DWP). (A.1, A.1.1, A.2)

Basis Discussion: RLD-VSL-00007 receives effluents from the HLW HDH, HLW HOP, and HSH. The maximum capacity of RLD-VSL-00007 is restricted by the dangerous waste portion of the Resource Conservation

and Recovery Act (RCRA) Permit (DWP WA7890008967) see Table III.10.E.C and is why this functional requirement exist.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analysis documenting that HLW-RLD vessel RLD-VSL-00007 is sized to accommodate the required effluent inflows.	
R	ENG	Review of design to ensure conformance to the results of the analysis and to the DWP requirements.	

3.5.1.3 Capacity of Vessel HLW RLD-VSL-00008

Requirement: The HLW-RLD vessel RLD-VSL-00008 shall be sized to accommodate the required effluent inflows; the vessel maximum capacity shall conform to the stated maximum capacities in the Dangerous Waste Permit (DWP). (A.1, A.1.1, A.1.4, A.2)

Basis Discussion: RLD-VSL-00008 receives effluents from the HLW HDH, HLW HOP, HSH, NLD, PCW, PWD racks drains, and C3/C5 area sumps. The maximum capacity of RLD-VSL-00008 is restricted by the dangerous waste portion of the Resource Conservation and Recovery Act (RCRA) Permit (DWP WA7890008967) see Table III.10.E.C and is why this functional requirement exist.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analysis documenting that HLW-RLD vessel RLD-VSL-00008 is sized to accommodate the required effluent inflows.	
R	ENG	Review of design to ensure conformance to the results of the analysis and to the DWP requirements.	

3.5.1.4 Capacity of Vessel HLW RLD-VSL-00002

Requirement: The HLW RLD vessel RLD-VSL-00002 shall be sized to accommodate the required effluent inflows; the vessel maximum capacity shall conform to the stated maximum capacities in the Dangerous Waste Permit (DWP). (A.1, A.1.2)

Basis Discussion: Vessel RLD-VSL-00002 receives condensate from the low points in the main offgas ducts downstream of the HEMEs (HOP-HEME-00001A/B and HOP-HEME-00002A/B); condensate from low points in the main PJV header; and plant wash for level makeup to assure a hydraulic seal. The maximum capacity of RLD-VSL-00002 is restricted by the dangerous waste portion of the Resource Conservation and Recovery Act (RCRA) Permit (DWP WA7890008967) see Table III.10.E.C and is why this functional requirement exist.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments

A	ENG	Analysis documenting that HLW-RLD vessel RLD-VSL-00002 is sized to accommodate the required effluent inflows.	
R	ENG	Review of design to ensure conformance to the results of the analysis and to the DWP.	

3.5.1.5 Vessels Overflow Feature Design

Requirement: The HLW-RLD vessels (RLD-VSL-00002, -00007, -00008) shall have an overflow feature consisting of vessel openings and attached piping sized to at least meet the maximum in-flow rate. [Section 6.7.5, 14.10.1.1, BOD] (C.1.3.1, C.1.3.2)

Basis Discussion: The overflow features for RLD-VSL-00002, RLD-VSL-00007, and RLD-VSL-00008 provide a flow pathway to avoid overfilling the vessel to the point where backflow could occur or over pressurization. The overflow lines are sized to at least meet the maximum in-flow rate without over pressurizing the vessels. The common overflow line for RLD-VSL-00007 and RLD-VSL-00008 has a loop seal to prevent air inflow into the PVV/HOP systems.

The overflow features on the RLD minimize the potential for effluents from the RLD vessels backflow to low contamination or radiation areas, which limits dose exposure of personnel.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review HLW-RLD vessel design for incorporation of an overflow feature.	
A	ENG	Perform an analysis to document that the overflow lines are sized correctly. (i.e., the overflow lines are sized to at least meet the maximum in-flow rate) without over pressurizing the vessels.	

3.5.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

None.

3.5.3 System Interface Requirements

The boundary limits for the interaction of the C3/C5 sumps and the HLW-RLD collection vessels start at the sumps ejectors or pump suction line. The system boundary between the HLW-RLD vessels and the PT Facility PWD is in the transfer piping 5 ft. outside the PT Facility.

3.5.3.1 Interface with HLW Melter Feed Process System

3.5.3.1.1 Receive Transfers from HOP Submerged Bed Scrubbers

Requirement: HLW-RLD vessels RLD-VSL-00007 and RLD-VSL-00008 shall be capable of receiving transfers from HOP submerged bed scrubbers (SBS) (HOP-SCB-00001/HOP-SCB-00002). (A.1.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to confirm that the HOP transfer line provides a connection between the HOP SBSs and RLD-VSL-00007 and RLD-VSL-00008.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.1.2 Receive Transfers from HOP Submerged Bed Scrubber Condensate Receiver Vessels

Requirement: HLW-RLD vessel RLD-VSL-00007 shall be capable of receiving transfers from HOP SBS condensate receiver vessels (HOP-VSL-00903/HOP-VSL-00904). (A.1.1)

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to confirm that SBS condensate receiver vessels are connected to the HLW-RLD RLD-VSL-00007.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.1.3 Receive Condensate from HOP High Efficiency Mist Eliminators

Requirement: HLW-RLD vessel RLD-VSL-00002 shall be capable of receiving condensate from low point drains in the offgas piping downstream of the high-efficient mist eliminators (HOP-HEME-00001A/B and HOP-HEME-00002A/B). (A.1.2)

Basis Discussion: The offgas drains collection vessel (RLD-VSL-00002) receives offgas condensate from a low point in the HEMEs.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that the offgas drains collection vessel (RLD-VSL-00002) interfaces with the HEMEs to receive condensate from their low point drains.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.2 Interface with Pulse Jet Ventilation System – Collect Condensate Drains

Requirement: HLW-RLD-VSL-00002 shall be capable of receiving condensate from the low point drain in the main PJV header. (A.1.2)

Basis Discussion: Removal of condensate prevents buildup and collapse of pipe, plugging, etc.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify that RLD-VSL-00002 receives condensate from low points in the main PJV header.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.3 Interface with Process Vessel Vent Exhaust System

Requirement: HLW-RLD vessels (RLD-VSL-00007 and RLD-VSL-00008) shall be capable of venting directly to the PVV header that feeds into the HOP. [Section 14.10.1, BOD] (C.1.1.1)

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify that RLD-VSL-00007 and RLD-VSL-00008 have vent connections to the PVV.	

3.5.3.4 Interface with C5V

Requirement: HLW-RLD vessel RLD-VSL-00002 headspace shall be capable of venting to the C5V via the overflow. (C.1.1.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify that RLD-VSL-00002 has vent connections to the C5V via the overflow.	

3.5.3.5 Interface with the HLW-Canister Decontamination Handling System

Requirement: HLW-RLD vessels RLD-VSL-00007 and RLD-VSL-00008 shall be capable of receiving transfers from the HLW waste neutralization vessel (HDH-VSL-00003). (A.1.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that RLD-VSL-00007 and RLD-VSL-00008 interfaces with the HLW waste neutralization vessel to receive transfers.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.6 Interface with HLW-Melter Cave Support Handling System

Requirement: HLW-RLD vessels RLD-VSL-00007 and RLD-VSL-00008 shall be capable of receiving wash transfers from decontamination tanks for melter caves 1 and 2 (HSH-TK-00001/00002). (A.1.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that HSH-TK-00001/00002 interfaces with the RLD-VSL-00007 and RLD-VSL-00008 to receive wash transfers.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.7 Interface with HLW-Melter Feed Process System

3.5.3.7.1 Receive Wash Water Transfer from HLW HFP

Requirement: HLW-RLD system RLD-VSL-00008 shall be designed with capability to receive heel flush transfers from the melter feed preparation vessels (HFP-VSL-00001, HFP-VSL-00005) and the melter feed vessels (HFP-VSL-00002 and HFP-VSL-00006) only during decontamination and decommissioning activities. (A.1.4)

Basis Discussion: Solution transfers from HFP-VSL-00001, HFP-VSL-00002, HFP-VSL-00005, and HFP-VSL-00006 to HLW-RLD can only happen with a configuration change to the steam ejectors and steam racks.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	HLW-RLD system RLD-VSL-00008 is designed to prevent receiving heel flush transfers from the melter feed preparation vessels in the normal operational configuration.	
R	ENG	The transfer piping/jumpers from the HFP vessels to RLD-VSL-00008 are designed with the capability to be reconfigured to receive heel flush transfers from the melter feed preparation vessels during decontamination and decommissioning activities. The design includes the elements required to reconfigure the system to receive heel flush transfers from the melter feed preparation vessels.	

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/COM	Verify that steam ejector steam supply piping can be reconfigured to receive heel flush transfers from the melter feed preparation vessels and the reconfiguration allows the flows required for decontamination and decommissioning.	

3.5.3.8 Interface with HLW-Plant Wash and Disposal System

3.5.3.8.1 Plant Wash and Disposal System – Addition of Sodium Hydroxide

Requirement: The HLW-RLD system shall interface with the HLW-PWD to add sodium hydroxide for pH adjustment of the effluent in RLD-VSL-00007 and RLD-VSL-00008 before transfer to the PT Facility. (A.5.1)

Basis Discussion: The sodium hydroxide for pH adjustment is delivered through the PWD rack.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interface between the PWD and the HLW-RLD vessels.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.8.2 HLW-Plant Wash and Disposal System – Vessel Wash Water

Requirement: The HLW-RLD vessels shall interface with the HLW-PWD to received DIW with nitric acid to wash and decontaminate the vessels and internals. [Sections 5.2, 14.1, 20.0, ORD] (B.1.2)

Basis: Decontamination is used to minimize the spread or buildup of radioactive contamination and that reduces dose rates during any maintenance or during decommissioning.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interface between the HLW-PWD and NAR systems and the HLW-RLD vessels to receive DIW and nitric acid for washing the vessels.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.9 HLW-Plant Wash and Disposal System – Vessel And Loop Seal Makeup Water

Requirement: HLW RLD-VSL-00002 and the overflow loop seals between HLW RLD-VSL-00007, RLD-VSL-00008, and HCP-SUMP-00001 shall have the capability to receive makeup water from the PWD rack. (A.5.2)

Basis Discussion: Receipt of effluent in the RLD-VSL-00002 is not driven by a transfer device; there is no operating sequence to initiate or shut off the transfer. When there is insufficient condensate incoming into RLD-

VSL-00002 from the offgas drains to balance evaporation, level makeup is added to the vessel to maintain a hydraulic seal.

The overflow loop seals between HLW RLD-VSL-00007, RLD-VSL-00008, and HCP-SUMP-00001 receive makeup water via PWD-RK-00032 to ensure a hydraulic seal that prevents black cell air from entering the vessels' headspace.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the makeup capability from the HLW-PWD to the HLW-RLD RLD-VSL-00002, and to the overflow loop seals between HLW RLD-VSL-00007, RLD-VSL-00008, and HCP-SUMP-00001.	

3.5.3.10 Interface with HLW-Plant Cooling Water System

Requirement: Capability shall be provided to drain PCW secondary loops to RLD-VSL-00008. (A.1.4)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that piping exists between the HLW-PCW drain header and RLD-VSL-00008.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.11 Interface with Nonradioactive Liquid Waste Disposal System

Requirement: HLW-RLD system RLD-VSL-00008 shall be capable of receiving off-spec effluents from the NLD C2 drain collection tank (NLD-TK-00006). (A.1.4)

Basis Discussion: This is an ALARA feature because it allows for the transfer of out of specification NLD waste into the RLD system which prevents contamination and provides an acceptable disposal route.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the transfer line interface between the C2 drain collection tank and the RLD-VSL-00008.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.12 Interface with Radiation Area (C3/C5) Sumps

Requirement: HLW-RLD system RLD-VSL-00008 shall be capable of receiving effluent from rad area (C3/C5) sumps. (A.1.3)

Basis Discussion: None.
Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the transfer line interface between the rad area (C3/C5) sumps and the RLD-VSL-00008.	
T	SU/COM	Verify that the HLW-RLD system is capable of receiving flows as designed.	

3.5.3.13 Interface with Decontamination Glove Box/Booth Effluents

Requirement: RLD-VSL-00008 shall be capable of receiving effluent from the decontamination glove box (WTP-MH-30-MHAN-00007) and the decontamination booth (WTP-MH-30-MHAN-00004) both of which are located in Room H-0311A. (A.1.4.1)

Basis Discussion: The drain transfers from the decontamination glove box and decontamination booth are considered routine but at low and undetermined frequency and volume.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the transfer line interface between the decon glove box/booth and the RLD-VSL-00008.	

3.5.3.14 Interface with Pretreatment Plant Wash and Disposal System

Requirement: The HLW-RLD shall be capable of transferring radioactively contaminated collected effluents in RLD-VSL-00007 or RLD-VSL-00008 to either the pretreatment HLW effluent transfer vessel (PWD-VSL-000043) or the pretreatment ultimate overflow vessel (PWD-VSL-00033). (A.6)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to confirm that HLW-RLD vessels (RLD-VSL-00007/RLD-VSL-00008) have the capability to transfer collected effluents to either PWD-VSL-00043 or PWD-VSL-00033.	
T	SU/COM	Demonstrate that the HLW-RLD system is capable of transferring effluents as designed.	

3.5.3.15 Interface with Autosampling System - Sampling

Requirement: The HLW-RLD shall provide interface with the WTP ASX to sample contents of HLW-RLD vessels RLD-VSL-00007 and RLD-VSL-00008, which shall include a recirculation loop to the ASX for sampling to return effluents back to the HLW-RLD vessels. [Section 6.7.4, BOD] [Section 14.14, ORD] (A.4)

Basis Discussion: The sampling transfer from either HLW-RLD vessel (RLD-VSL-00007/00008) is by the HLW-RLD sample and transfer pumps.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the piping design to confirm the sample lines provide the capability to recirculate sample fluid between the ASX and HLW-RLD vessels RLD-VSL-00007 and RLD-VSL-00008.	
T	SU/COM	Demonstrate the sampling function of the HLW-RLD via the ASX system.	

3.5.3.16 Interface with Autosampling System – Receive Autosampler Drains

Requirement: The HLW-RLD shall provide interface with the WTP ASX to receive drains from the autosampler ASX-SMPLR-00028 confinement boundary. (A.1.4.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to confirm that the ASX-SMPLR-00028 drains are routed to HLW-RLD.	

3.5.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.5.4.1 Vessel Washing

Requirement: The HLW-RLD vessels (RLD-VSL-00002/00007/00008) shall be equipped with internal spray mechanisms. [Sections 11.7.4, 16.4.8, BOD] [Sections 14.1, 14.2, 14.8, 20.0, ORD] (B.1.2)

Basis Discussion: The internal spray mechanism in the vessels facilitates the removal of contamination and prevents the buildup of solids on the vessel walls. The HLW-RLD vessels are to be cleaned prior to removal for decontamination and decommissioning. This requirement is ALARA affecting because the function of the internal spray mechanism is to reduce the dose rates on the vessel during decommissioning.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review vessel design documents to verify the RLD vessels contain internal spray mechanisms.	

3.6 Piping Requirements

3.6.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.6.1.1 Piping Design

3.6.1.1.1 High Point Vent for RLD Process Transfer and Sample Pipes

Requirement: HLW-RLD process lines shall have high point valves and vent lines from the RLD transfer lines with flush capability. Process piping high point vents shall be vented to PVV for hydrogen mitigation. [Section 14.10.1, BOD] (C.1.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review HLW-RLD process lines design to verify high point valves, vent lines, and flushing capability.	

3.6.1.1.2 Siphon Prevention

Requirement: The HLW-RLD piping (inclusive of PJM and steam ejector supply and exhaust piping) extending below the maximum liquid level in vessels, sumps or breakpots, shall be designed to prevent siphoning by one of the following methods: (1) ensuring one barometric head of isolation (via 34 ft vertical run), (2) piping to a destination vessel/tank that is open to air and where the discharge is always located above the maximum liquid level, or [if (1) and (2) are not practicable] (3) use of an engineered siphon breaker. [Section 7.1, 14.3, ORD] [Section 5.1.2, BOD] [Section 4.4.7.4, 5.6. 7, PDSA-HLW Facility]

Basis Discussion: One barometric head on service piping lines prevents contamination spread up these utility or process lines (accomplished by 34 ft. of vertical pipe or piping to a destination outside of C5 area). This requirement is ALARA affecting because it prevents contamination from spreading from high contamination to low contamination areas thereby minimizing the dose rates in the affected areas. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design for conformance with siphoning prevention requirements.	Document in DVR

3.6.1.1.2.1 Siphon Prevention – Steam Line Shielding

Requirements: The HLW RLD steam lines directly interfacing with systems containing highly radioactive material and that are designed to preclude siphoning via barometric head isolation, shall be routed in a shielded area until 34 ft of barometric isolation is achieved. [Section 3.3.5.2.8, PDSA-HLW Facility]

Basis Discussion: The 34 ft vertical run does not need to be continuous but the shielding must be provided until the total vertical distance is achieved.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design for conformance with shielding requirements for RLD steam lines entering systems containing highly radioactive material.	Document in DVR

3.6.1.1.3 Double-Walled (Coaxial) Piping

Requirement: The RLD system transfer lines between the PT Facility and HLW Facility shall be coaxial piping.
[Section 11.2.3, BOD]

Basis Discussion: To provide a dual containment boundary for transferring the HLW concentrate between the PT Facility and HLW Facility. Radioactive liquid transfer lines are double-encased to minimize potential for release of contamination due to breach of the process line as part of ALARA design process.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the piping design drawings to confirm design specifies the use of co-axial piping for transfer piping of between the HLW and the PT Facilities.	

3.6.1.1.3.1 Coaxial Pipe Leak Detection

Requirement: Co-axial lines (pipe-in-pipe) shall have provision for leak detection in the outer coaxial pipe.
[Section 11.3.5.2, BOD] [Section 14.3, ORD]

Basis Discussion: The leak detection capability is provided for the entire length of the transfer line from the HLW-RLD vessels to the PT PWD vessels.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review piping design to verify that there are provisions for leakage detection for the coaxial lines.	

3.6.1.1.4 RLD and PVV Bulge Drains

3.6.1.1.4.1 RLD and PVV Bulge Drains - Sizing

Requirement: The RLD and PVV bulge drain(s) shall be sized to gravity drain at a rate equal to or exceeding the maximum possible discharge rate from RLD-PMP-00018 or RLD-PMP-00019, as applicable, while maintaining a static head that does not exceed the elevation of the nozzle for the HEPA filter inbleed line. [Section 4.4.31.4, PDSA - HLW Facility]

Basis Discussion: The safety function of the drain lines is to provide an unobstructed relief path for the bounding release flow rate into the bulge. The RLD and PVV bulge drains are credited as a safety significant (SS) control. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify by analysis that RLD and PVV bulge drain(s) are sized to accommodate a flow rate equal to or exceeding the maximum possible discharge rate from RLD-PMP-00018 or RLD-PMP-00019 that does not exceed the elevation of the nozzle for the HEPA filter inbleed line.	
R	ENG	Review the piping design to verify conformance with the analysis.	May be documented in an assessment/evaluation.

3.6.1.1.4.2 RLD and PVV Bulge Drains – Weir and Strainer Design

Requirement: The RLD and PVV bulge drain(s) design shall include a weir and a strainer to minimize the collection of coarse materials. [Section 4.4.31.4, PDSA - HLW Facility]

Basis Discussion: The safety function of the drain lines is to provide an unobstructed relief path for the bounding release flow rate into the bulge. The RLD and PVV bulge drains are credited as a safety significant (SS) control. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the RLD and PVV bulge drain design to verify inclusion of a weir and a strainer.	May be documented in an assessment/evaluation.

3.6.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.6.2.1 Mechanical Isolation of Supply Lines

Requirement: The utility supply lines (e.g., air, steam and plant wash) to the HLW-RLD vessels shall include provisions to mechanically isolate utility lines from all waste transfer lines that could potentially result in contaminating the utility supply lines. [Sections 7.1, ORD] [Section 5.1.2, BOD]

Basis Discussion: This mechanical isolation design feature (e.g., valves, blind flange, spectacle blinds, or capped lines) ensures no connection exists between the utility supply to prevent backflow of contamination.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the piping design to confirm mechanical isolation capabilities on supply lines.	May be documented in an assessment/evaluation.

3.6.3 System Interface Requirements

3.6.3.1 RLD System Line Flushing via Demineralized Water System

Requirement: The piping design shall interface with the following systems to provide flush of DIW directly or through the PWD racks into the following lines: [Section 14.3, 20.0, ORD] (B.1.1, B.1.3, B.1.3.1, B.1.3.2, B.1.3.3, B.1.3.4, B.1.3.5)

- Piping from RLD-VSL-00007 and RLD-VSL-00008 to PWD-VSL-00033 and PWD-VSL-00043
- Between RLD-VSL-00007 and RLD-VSL-00008 to ASX-SMPL-00028
- RLD-VSL-00007 recirculation line from the RLD transfer/sample pumps
- RLD-VSL-00008 recirculation line from the RLD transfer/sample pumps
- Level detection bubbler lines in RLD-VSL-00007 and RLD-VSL-00008

Basis Discussion: Flushing capability is provided for piping systems to limit accumulation of solids in process piping.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of P&IDs for required connections.	
T	SU/COM	Demonstrate the capability to flush the following HLW-RLD lines: • RLD line from RLD-VSL-00007 to ASX-SMPL-00028 • RLD line from RLD-VSL-00008 to ASX-SMPL-00028 • RLD line from ASX-SMPL-00028 to RLD-VSL-00007 • RLD line from ASX-SMPL-00028 to RLD-VSL-00008 • RLD line from RLD-PMP-00018 to PWD-VSL-00043 • RLD line from RLD-PMP-00019 to PWD-VSL-00043 • RLD line form RLD-PMP-00018 to PWD-VSL-00033 • RLD line from RLD-PMP-00019 to PWD-VSL-00033 • RLD line from RLD-PMP-00018 to RLD-VSL-00007 • RLD line from RLD-PMP-00019 to RLD-VSL-00007 • RLD line from RLD-PMP-00018 to RLD-VSL-00008 • RLD line from RLD-PMP-00019 to RLD-VSL-00008	

3.6.3.2 Interface with Process Vessel Vent Exhaust System

Requirement: Process piping high points shall be vented to the PVV for hydrogen mitigation. (C.1.2)

Basis Discussion. None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that all HLW-RLD high point vent lines are connected to the PVV.	

3.6.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.6.4.1 RLD Process Line Maximum Velocity Requirements

Requirement: The HLW-RLD system piping containing slurries shall be designed to not exceed the following maximum velocities:

- 10 ft/sec. with glass formers (Case 1)
- 12 ft/sec. for less than 2wt% slurries without glass formers (Case 2)
- 12 ft/sec. for greater than 2wt% slurries without glass formers (Case 3)

[Appendix H 4.0, SRD]

Basis Discussion: The bulk velocity of slurries containing glass formers, within piping, and the free stream velocity along the wall of vessels should be less than 10 fps. The required wear allowance for slurries containing glass formers having velocities greater than 10 fps, or by the use of other materials of construction (other than stainless steel)are justified by calculation. The maximum flow velocities are established to limit erosion to less than the values stated in SRD Appendix H, section 4.0 over a 40 year life for 304L and 316L stainless steel (0.125 inches for case 1; 0.004 inches for case 2; 0.016 inches for case 3). Erosion values are further considered in the overall erosion/corrosion values to be applied to the design per section 3.4.1.2.2. A minimum flow velocity for slurry lines is determined by 24590-WTP-GPG-M-0058. This design guide applies only to Newtonian fluids (RLD effluents are Newtonian).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis of pump and line sizing to and line sizing to ensure the SRD requirement is met.	
R	ENG	Review for maximum transfer velocity design to verify conformance with analysis.	May be documented in an assessment/evaluation.

3.6.4.2 Pipe Draining and Slopes

Requirement: The fluid piping design shall have provisions to drain the piping and shall have no traps or pockets that can accumulate liquids or solids that cannot be drained either by operator action or through free draining design. [Sections 7.1, 14.3, 20.0, ORD] [Section 11.3.1, 16.4.2.7, BOD]

Basis Discussion: For additional details on pipe sloping, see 24590-WTP-GPG-M-027, *Recommended Slopes for Piping System*, and slope requirements on P&ID symbols and 24590-WTP-M6-50-00008 , *Legend Sheet 8 of 8*. Level piping for a short distance through wall penetrations, at connections to equipment, and at jumpers is acceptable (Section 14.3, ORD). In-cell instrument air lines connected using flexible jumpers are not considered process piping and are not required to be sloped (Section 7.1, ORD).

This is an ALARA feature because it ensures the pipes are drained of radioactive material if maintenance needs to be performed, and during decommissioning, which reduces dose and potential personnel contamination.

Continuous sloping and prohibition of low spots in the RLD and PVV bulges drain lines, to minimize the collection of materials, is credited in the hazards and accident analysis as a safety significant (SS) function. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the HLW-RLD fluid piping design (i.e., P&IDs) to confirm piping is designed to drain.	
I	CON	Document inspection of installed lines to confirm draining and slope requirement.	May cite inspection records or assessment

3.6.4.2.1 Vacuum Breaker in Piping

Requirement: Liquid piping design shall include the capability to break a vacuum in a transfer line as required to allow gravity liquid draining. [Section 7.1, ORD]

Basis Discussion: In the context of HLW-RLD, "*transfer line*" refers to the HLW-RLD piping that delivers effluents from HLW to PTF. The addition of a vacuum breaker to a transfer line ensure that when negative pressures occur in the pipe during operation, air will be admitted and swept in the pipe, thereby restoring normal flow.

This is an ALARA feature because it allows lines to completely drain.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the HLW-PWD-RLD fluid piping design (i.e., P&IDs) to confirm that a means of breaking vacuum is provided in transfer lines.	

3.6.4.3 Ability to Isolate HLW to Pretreatment Transfer Piping

Requirement: The HLW-RLD system shall have the ability to isolate the transfer pipe between the HLW Facility and PTF vessels (RLD-VSL-00007, RLD-VSL-00008, PT-PWD-VSL-00043, and PT-PWD-VSL-00044). [Section 11.4.7, BOD]

Basis Discussion: This is needed to provide the capability for phased commissioning between facilities.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review applicable HLW-RLD P&IDs to confirm the capability to isolate transfer lines between RLD-VSL-00007, RLD-VSL-00008, PT-PWD-VSL-00043, and PT-PWD-VSL-00044.	

3.6.4.4 Cathodic Protection

Requirement: Underground HLW-RLD underground transfer piping between RLD-VSL-00007, RLD-VSL-00008, PT-PWD-VSL-00043, and PT-PWD-VSL-00044 shall be cathodically protected. [Section 8.9, BOD]

Basis Discussion: None.

Verification: Verification is achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that HLW-RLD underground piping between RLD-VSL-00007, RLD-VSL-00008, PT-PWD-VSL-00043, and PT-PWD-VSL-00044 are cathodically protected.	

3.7 Pump/Ejector Requirements

3.7.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.7.1.1 Sump Pump/Ejector Transfer Rate

Requirement: The minimum transfer rate for the sump pumps/ejectors listed below is based on the removal of the bounding source volume in 24 hours as required by the Washington State Administrative Code (WAC) [Section 14.10.1.2, BOD]

The following sumps are provided with leak detection capability as described in the WTP Dangerous Waste Permit:

RLD-SUMP-00001, HDH-SUMP-00001, HDH-SUMP-00002, HDH-SUMP-00003, HFP-SUMP-00002, HFP-SUMP-00005, HCP-SUMP-00001, HOP-SUMP-00003, HOP-SUMP-00008, HPH-SUMP-00001, HPH-SUMP-00003, HPH-SUMP-00005, HSH-SUMP-00003, HSH-SUMP-00007, HSH-SUMP-00008, and HSH-SUMP-00009

Basis Discussion: The removal of spills or leak within 24 hours or in as a timely manner as possible. This is applicable to all RLD sump pumps and ejectors.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify sumps can be emptied per requirement.	
R	ENG	Review design for conformance to the requirement.	
T	SU/COM	Perform test to verify RLD sump pumps/ejectors are capable of meeting the required transfer rate.	

3.7.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

None.

3.7.3 System Interface Requirements

3.7.3.1 Interface with High Pressure Steam

Requirement: The HPS system shall provide sufficient steam flow to the steam-motivated ejectors used to transfer effluent from RLD vessel RLD-VSL-00002 and from HLW Facility sumps that discharge to the RLD system via ejectors. (A.1.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that the HPS provides steam to steam-motivated ejectors in RLD-VSL-00002 and in HLW Facility sumps that discharge to the RLD system via ejectors.	
T	SU/COM	Demonstrate that the HLW-RLD is capable of transferring effluents as designed.	

3.7.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.7.4.1 Pump Seals

Requirement: Pump seals or other design features, upon failure, shall not provide a pathway for liquids or gases to personnel or to the environment. [Section 14.1, ORD]

Basis Discussion: HLW-RLD transfer/sampling pumps are anticipated to be located in a bulge that provides protection to personnel and the environment. The spread of contaminants (liquids or gases) to personnel or to the environment is minimized by using pump seals or other design features.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that the RLD transfer/sampling pumps are located in a bulge or otherwise designed to preclude leakage of liquids/gases that could lead to exposure to the workers or the environment.	

3.7.4.2 Backflow and Steam Collapse Prevention

Requirement: The steam ejectors shall be provided with the capability to prevent collapse of steam and the resulting backflow of contamination. [Section 14.1, ORD]

Basis Discussion: Air is used after a transfer in order to prevent steam collapse. This requirement is ALARA because it prevents the spread of contamination from high contamination areas to low contamination areas. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that steam ejectors and associated components have the capability to prevent collapse of steam and the resulting backflow of contamination.	
T	SU/COM	Demonstrate the capability to use air to purge steam lines for the RLD steam ejectors.	

3.8 Pulse Jet Mixers

3.8.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.8.1.1 General Agitation/Mixing

Requirement: The HLW-RLD shall use PJMs to agitate/mix and suspend solids present in the effluents during the process of receiving, storing, sampling and transferring effluents. [Section 6.7.3, BOD] [Section 14.14, ORD] (A.3.2)

Basis Discussion: The contents of the RLD vessels (RLD-VSL-00007/8) are mixed to ensure that the process control requirements are met and a representative sample can be obtained.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing confirming that the RLD effluents can be agitated, mixed and suspended by the PJMs sufficiently for sampling/process control.	
R	ENG	Verify PJMs are incorporated into the design and align with mixing requirements from the analysis or test results.	

3.8.1.2 Mixing Requirements

The HLW-RLD has the requirement for both liquid-liquid and solid-liquid agitation. The requirements are as follows:

3.8.1.2.1 Re-suspend Solids

Requirement: HLW-RLD system vessels RLD-VSL-00007 and RLD-VSL-00008 shall be capable to re-suspend settled solids in the effluent received. [Section 6.7.3, BOD] (A.3.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing confirming that the RLD settled solids in the vessels with PJMs will be re-suspended by the PJMs	
R	ENG	Verify PJMs are incorporated into the design and align with the mixing re-suspension requirements from the analysis or test results.	Design conforms to as tested configuration

3.8.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

None.

3.8.3 System Interface Requirements

3.8.3.1 Pulse Jet Mixer Lines Flushing via DIW

Requirement: PJM air supply lines shall interface with demineralized water system through the DIW racks to provide a means of flushing/cleaning the PJM lines when cleaning/decontamination is required. (B.1.3.4)

Basis Discussion: The PJM air supply lines are to be capable of being flushed downstream of the jet pump pairs (JPP). The PJM lines are flushed to minimize the buildup of radioactive contamination and therefore reduce the overall radiation in the area.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine DIW flushing can be achieved.	
R	ENG	Review of design to verify the PJM air lines are provided with connections to the DIW racks.	
T	SU/COM	Verify DIW is capable of flushing the PJM lines.	

3.8.3.2 ISA – Pulse Jet Mixer Motive Air

Requirement: The ISA shall deliver sufficient compressed air at design operating conditions to meet the functional mixing requirements for RLD vessels RLD-VSL-00007/8. (A.3.1)

Basis Discussion: This requirement applies to each of the four PJMs installed in RLD vessels RLD-VSL-00007 and RLD-VSL-00008.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform an analysis or testing to determine the ISA requirements for the PJMs.	
R	ENG	Review design for conformance with analysis/results testing.	
T	SU/COM	Perform operational test to demonstrate the required compressed air is delivered to the PJM at the rate specified per analysis.	

3.8.3.3 Interface with Pulse Jet Ventilation System – Vent PJM Exhaust Air

Requirement: HLW-RLD-VSL-00007 and HLW-VSL-00008 pulse jet mixers (PJM) exhausts shall be delivered to the PJV system. (A.1.2)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Verify by analysis or testing the PJM exhaust rate.	
R	ENG	Review of design to verify that RLD-VSL-00007 and RLD-VSL-00008 pulse jet mixers exhaust to the PJV system in conformance with the analysis.	

3.8.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.9 Monitor, Report and Control System Conditions

3.9.1 Mission and Functional/Performance Requirements (Including States/Modes)

3.9.1.1 HLW-Radioactive Liquid Waste Disposal System Vessels

3.9.1.1.1 Process Parameters Monitoring – RLD-VSL-00002/7/8

Requirement: HLW-RLD vessels RLD-VSL-00002, RLD-VSL-00007 and RLD-VSL-00008 shall include temperature, pressure and level sensing capabilities and interface with the PCJ to remotely monitor pressure and effluent level within the vessels. [Section 14.10.1.1, BOD] (D.1.1) (D.1.2)

Basis Discussion: Temperature and pressure monitoring provide the capability to ensure the effluents within the vessels are maintained within the system specified operating range. Effluent level is monitored to prevent overflows and to provide data on the effluent level in the vessels before the effluents are transferred. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design for the interface capability to remotely monitor the temperature, pressure and level within HLW-RLD-VSL-00002, HLW-RLD-VSL-00002 and RLD-VSL-00008 vessels.	
T	SU/COM	Verify the capability to remotely monitor the HLW-RLD-VSL-00002, HLW-RLD-VSL-00007 and RLD-VSL-00008 temperature, pressure and level.	

3.9.1.1.2 High Liquid Level Permissive – RLD-VSL-00007/8

Requirement: The following components, which enable discharge paths to RLD-VSL-00007 or RLD-VSL-00008, shall interface with the PCJ system to receive a high liquid level signal if the level in RLD-VSL-00007 or RLD-VSL-00008 (as appropriate) exceeds the high setpoint: (1) HLW-RLD valves that isolate the supply motive fluid (compressed air or steam) to the sump pumps/ejectors discharging to the vessels, (2) HLW-RLD transfer pumps (i.e., RLD-PMP-00018/19), (3) pumps or valves from other systems (e.g., HSH-PMP-00001/2) discharging to the vessels. Sump pumps/ejectors supply valves shall be prevented from opening upon receipt of the high liquid level signal. Pumps shall be prevented from running upon receipt of the high liquid level signal. (WAC 173-303-640[5][b][ii]) (WAC 173-303-640[5][b]). [Sections 7.3.4, 14.10.1.1, BOD] (D.1.4)

Basis Discussion: This control is necessary to ensure that transfers to RLD-VSL-00007/8 cannot be initiated if the vessel(s) content levels exceed the high level setpoint. The sump diaphragm pumps are powered by instrument service air. The steam ejectors are powered by steam. Valves supplying air to the diaphragm pumps or steam to the steam ejectors must be opened to initiate the transfer process. If the PCJ system receives a signal that the RLD-VSL-00007/8 content levels exceed high level setpoint, those valves are prevented from opening. Similarly, pumps that perform transfers to RLD-VSL-00007/8 cannot receive a start signal when the vessels high level setpoint is exceeded. The RLD transfer pumps are included since they can transfer between the two vessels.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design to ensure that transfers to vessel RLD-VSL-00007/8 from the following cannot be initiated when a high liquid level setpoint signal is received: (1) sump/pump ejectors, (2) RLD transfer pumps, and (3) pumps or valves from other systems (e.g., HSH-PMP-00001/2) discharging to RLD-VSL-00007/8.	
T	SU/COM	Perform operational test to verify the following upon receiving a high liquid level signal at the required setpoint from vessel RLD-VSL-00007/8: (1) valves that supply the motive fluid to the diaphragm pumps or steam ejectors cannot open, and (2) pumps discharging to RLD-VSL-00007/8 cannot start.	

3.9.1.1.3 High-High Liquid Level Interlock – RLD-VSL-00007/8

Requirement: The following components, which enable discharge paths to RLD-VSL-00007 or RLD-VSL-00008, shall interface with the PCJ system to receive a high-high liquid level signal if the level in RLD-VSL-00007 or RLD-VSL-00008 (as appropriate) exceeds the high-high setpoint: (1) HLW-RLD valves that isolate the supply motive fluid (compressed air or steam) to the sump pumps/ejectors discharging to the vessels, (2) HLW-RLD transfer pumps (i.e., RLD-PMP-00018/19), (3) pumps or valves from other systems (e.g., HSH-PMP-00001/2) discharging to the vessels. Sump pumps/ejectors supply valves shall close upon receipt of the high-high liquid level signal. Pumps shall stop upon receipt of the high-high liquid level signal. (WAC 173-303-640[5][b][ii]) (WAC 173-303-640[5][b]). [Sections 7.3.4, 14.10.1.1, BOD] (D.1.4)

Basis Discussion: This control is necessary to ensure that transfers to RLD-VSL-00007/8 are precluded if the vessel(s) content levels exceed high-high level setpoint. If the PCJ system receives a high-high signal from RLD-VSL-00007/8, valves that enable transfer devices (sump pumps or ejectors) are must close to stop the transfer. Similarly, pumps that perform transfers to RLD-VSL-00007/8 must stop when the vessels high level setpoint is exceeded. The RLD transfer pumps are included since they can transfer between the two vessels. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design to ensure that transfers to vessel RLD-VSL-00007/8 from the following are stopped when a high-high liquid level setpoint signal is received: (1) sump/pump ejectors, (2) RLD transfer pumps, and (3) pumps or valves from other systems (e.g., HSH-PMP-00001/2) discharging to RLD-VSL-00007/8.	
T	SU/COM	Perform operational test to verify that, upon receiving a high-high liquid level signal from vessel RLD-VSL-00007 or RLD-VSL-00008 (as appropriate) at the required setpoint, : (1) valves that supply the motive fluid to the diaphragm pumps or steam ejectors close, and (2) pumps discharging to RLD-VSL-00007/8 stop.	

3.9.1.1.4 Low-Low Liquid Level Interlock - RLD-VSL-00007/8

Requirement: The HLW RLD sample/transfer pumps (RLD-PMP-00018/19) shall stop when interlock signal from PCJ system is received, indicating that vessel RLD -VSL-00007 or vessel RLD-VSL-00008 is at the low-low level setpoint. [Section 7.3.4, BOD] (D.1.4)

Basis Discussion: The PCJ system initiates an alarm and sends a trip signal to stop the RLD sample/transfer pumps when vessel RLD-VSL-00007 or vessel RLD-VSL-00008 is at the low-low level setpoint. This stops the transfer of effluents from the vessels in order to leave sufficient heel in the vessels for proper operation of PJMs.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of the RLD-VSL-00007/8 low-low liquid level and RLD sample/transfer pumps (RLD-PMP-00018/19) interlock.	
T	SU/COM	Perform operational test to verify that a low-low liquid level at the required setpoint(s) from the vessel RLD-VSL-00007 or vessel RLD-VSL-00008 stops the RLD sample/transfer pumps (RLD-PMP-00018/19)	

3.9.1.1.5 Low-Low Liquid Level Interlock – RLD-VSL-00002

Requirement: At the low-low liquid level setpoint for vessel RLD-VSL-00002, the PCJ system shall initiate an alarm and send a trip signal to close the RLD-VSL-00002's transfer ejectors valves. [Section 7.3.4, BOD] (D.1.4)

Basis Discussion: This control is necessary to ensure that there is sufficient heel in the vessel for proper operation and to prevent loss of a pressure boundary

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of RLD-VSL-00002 low-low liquid level alarm and trip signal to close ejectors valves used to facilitate transfer of effluents from RLD-VSL-00002.	
T	SU/COM	Perform operational test to verify that a low-low liquid level signal, at the required setpoint, from RLD-VSL-00002 closes ejector valves used to facilitate transfer of effluents from RLD-VSL-00002.	

3.9.1.2 HLW-Radioactive Liquid Waste Disposal System Sumps

3.9.1.2.1 Sump Liquid Monitoring

Requirement: All sumps discharging to RLD vessels shall include liquid level sensing capability and interface with PCJ system to remotely monitor liquid in the sumps. [Section 16.4.1.3, BOD] (D.1.2)

Basis Discussion: Liquid level in the sumps is monitored to ensure that high liquid level or low liquid level in the sumps is detected and action is taken to prevent adverse consequences to the RLD system and the HLW facility.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design for the interface capability to remotely monitor the liquid within the sumps discharging to the RLD vessels (RLD-VSL-00007/8).	
T	SU/COM	Verify the capability to remotely monitor liquid within the sumps discharging to the RLD vessels (RLD-VSL-00007/8).	

3.9.1.2.2 High-High Liquid Level Alarm and Trip for Selected Sumps

Requirement: At the high-high level setpoint for selected sumps the PCJ system shall initiate an alarm and send a trip signal to close the valve that supplies PWD to the wash nozzles to rinse down the cell or cave liner where the sump is located in. This requirement only applies to the following sumps: HSH-SUMP-00002, HSH-SUMP-00003, HSH-SUMP-00005, HSH-SUMP-00007, HFP-SUMP-00002, HFP-SUMP-00005, HOP-SUMP-00003, HOP-SUMP-00008, and HCP-SUMP-00001. [Section 7.3.4, 14.10.1.2, 14.10.1.3, 16.4.1.3, BOD] (D.1.4)

Basis Discussion: The purpose of these actions is to prevent excessive liquid accumulation in the cells that the sumps are located in.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of sumps high-high level alarms and trip signal to close the valves supplying the PWD to the sumps.	
T	SU/COM	Verify that upon receiving a high-high liquid level signal from sumps listed above valves supplying PWD to the sumps close and an alarm is annunciated.	

3.9.1.2.3 High Liquid Level Alarm and Trip for Selected Sumps

Requirement: At the high level setpoint for selected sumps the PCJ system shall initiate an alarm and send a trip signal to close the valves that supply water/effluent directly to the sumps. This requirement only applies to sumps HCP-SUMP-00001 and RLD-SUMP-00001. [Section 7.3.4, 14.10.1.2, 14.10.1.3, 16.4.1.3, BOD] (D.1.4)

Basis Discussion: The purpose of these actions is to prevent excessive liquid accumulation in the cells that the sumps are located in.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of sumps HCP-SUMP-00001 and RLD-SUMP-00001 high level alarms and trip signal to close the valves that supply water/effluent directly to the sumps.	
T	SU/COM	Perform operational test to verify that upon receiving a high liquid level signal from the sumps listed above, (1) an alarm is initiated, and (2) the valves that supply water/effluent directly to the sumps close.	

3.9.1.2.4 Low Liquid Level Alarm and Trip for Sumps

Requirement: At the low liquid level setpoint for all of the individual sumps the PCJ system shall initiate an alarm and send a trip signal to close the valves used to facilitate transfer (by supplying air to the air diaphragm pumps or high pressure steam ejectors). [Section 7.3.4, BOD] (D.1.4)

Basis Discussion: The purpose of the actions is to prevent high temperature steam from being directed to the vessels or manifolds (for sumps with ejectors) and to protect the sumps pumps (for sumps with pumps).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of sumps low level alarms and trip signal to close valves used to facilitate transfer.	
T	SU/COM	Perform operational test to verify that, upon receiving a low liquid level signal from the sumps, valves used to facilitate effluent transfer close.	

3.9.1.3 HLW-Radioactive Liquid Waste Disposal System Pumps/Ejectors and Piping

3.9.1.3.1 Temperature Monitoring - HLW-RLD Manifold

Requirement: The HLW-RLD piping manifolds shall include temperature sensing capability and interface with PCJ system to remotely monitor effluent temperature within the RLD manifolds. (D.1.3)

Basis Discussion: The effluent temperature in the RLD piping manifold is monitored to detect when the effluent being transfer to the RLD vessels is at a temperature that might damage the RLD equipment/components

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design for the interface capability to remotely monitor the effluent temperature within the RLD manifolds.	
T	SU/COM	Verify the capability to remotely monitor effluent temperature within the RLD manifolds.	

3.9.1.3.2 High-High Temperature Alarm and Trip - HLW-RLD Manifold

Requirement: At the high-high temperature setpoint for manifolds, the PCJ system shall initiate an alarm and send a trip signal to close the sump/vessel's transfer ejector valves that transfer to the RLD manifolds. [Sections 7.3.4, BOD] (D.1.4)

Basis Discussion: These actions prevent the ejectors transferring to the RLD manifolds from sending a significant amount of high temperature steam into the headers and lines.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the control logic design for incorporation of the manifolds high-high temperature alarm and trip signal to close the sumps/vessel's transfer ejector valves that transfer to the RLD manifolds.	
T	SU/COM	Perform operational test to verify that upon receiving a high-high temperature signal from the RLD manifold (1) an alarm is initiated and (2) the sump/vessel's transfer ejector valves that transfer effluents to the RLD manifolds close.	

3.9.1.3.3 HLW-RLD Seal Loop Level Monitoring

Requirement: Seal loop on RLD Vessels (RLD-VSL-00007/8) overflow lines shall include liquid level sensing capability and interface with PCJ system to remotely monitor liquid level in the seal loop. [Section 14.10.1, BOD] (D.1.4)

Basis Discussion: The seal loop is equipped with level instrumentation to monitor the water level in the seal loop. Water is added to the overflow seal loop to maintain the required seal if the level in the seal loop is too low.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design for the interface capability to remotely monitor the liquid level within the HLW-RLD seal loops.	
T	SU/COM	Verify the capability to remotely monitor liquid level within the HLW-RLD overflow seal loop.	

3.9.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.9.2.1 Leak Detection - Sumps

Requirement: The HLW-RLD system shall provide leak detection capable of detecting a leak of at least 0.1 gallons per hour within 24 hours, due to the failure of the primary containment, the presence of any release of dangerous waste, or accumulated liquid in the secondary containment system. [Sections 14.10.1.2, 14.10.1.3, 14.10.2.1, BOD] [Section III.10.E.9, DWP WA7890008967] (D.1.2)

The following sumps are provided with leak detection capability as described in the WTP Dangerous Waste Permit:

RLD-SUMP-00001, HDH-SUMP-00001, HDH-SUMP-00002, HDH-SUMP-00003, HFP-SUMP-00002, HFP-SUMP-00005, HCP-SUMP-00001, HOP-SUMP-00003, HOP-SUMP-00008, HPH-SUMP-00001, HPH-SUMP-00003, HPH-SUMP-00005, HSH-SUMP-00003, HSH-SUMP-00007, HSH-SUMP-00008, and HSH-SUMP-00009.

Basis Discussion: The HLW-RLD provides leak detection capability to detect the presence of any release of mixed or dangerous waste, or accumulated liquid in the secondary containment system, to indicate the need for transfer until collected material is removed.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify that sumps are capable of leak detection required.	
R	ENG	Review the design to confirm that the sumps identified in the basis discussion has liquid detection capability at the minimum level or rate of rise in conformance with the analysis.	
T	SU/COM	Verify the leak detection capability for sumps (discharging to the RLD Vessels) as described in the WTP Dangerous Waste Permit.	

3.9.2.2 Autosampler/Pump Interlock – High Liquid Level

Requirement: The HLW-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) shall be interlocked with the autosampler (ASX-SAMPLR-00028) to receive a pump stop signal from PPJ when liquid level in the autosampler reaches a predetermined high-level setpoint. [Section 4.4.19.3, PDSA - HLW Facility] (D.1.4)

Basis Discussion: This SS interlock mitigates the consequences of an accident by stopping sample feed upon detection increase of liquids inside the autosampler enclosure boundary. The interlocks are designed to ensure that the RLD-VSL-00008 sample process operation is stopped to prevent the autosampler confinement boundary from being over filled with sample liquid due to a sample feed or return line pipe break. Without the interlock (liquid level indicators interlocked with the HLW-RLD pumps), the autosampler enclosure and drain could be overwhelmed with sample liquid from RLD-VSL-00007 or RLD-VSL-00008 and breach the autosampler enclosure, spilling into a C3 area. This situation could potentially result in "high" direct-radiation dose consequences to the facility worker.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify inclusion of autosampler/pump liquid level interlock, as required.	

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/COM	Verify that a high liquid level signal from the autosampler (ASX-SAMPLR-00028) level instrumentation via PPJ stops the HWLR-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019).	

3.9.2.3 Autosampler/Pump Interlock - Flushing

Requirement: The HLW-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) shall be interlocked with the autosampler (ASX-SAMPLR-00028) to receive a pump stop signal from PPJ when associated valves are aligned for flushing activities prior to initiating the flushing activity. [Section 4.4.19.3, PDSA - HLW Facility]

Basis Discussion: This SS interlock reduces the probability of direct radiation exposure to the facility worker by ensuring that the sample process operations are stopped before flushing.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify inclusion of autosampler/pump flushing interlock, as required.	
T	SU/COM	Verify that the HLW-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) are prevented from running via signal from PPJ when valve associated with the autosampler (ASX-SAMPLR-00028) flushing are aligned for flushing.	

3.9.3 System Interface Requirements

3.9.3.1 Process Control System– Instruments

Requirement: Instruments connected to the PCJ shall not perform any active safety function. Instruments connected to the PCJ may include and perform safety boundary and retention functions. RLD instruments shall use standard commercially available instrumentation and communication protocols to interconnect to the PCJ. Fieldbus or Modbus communication shall be used. [Section 9.4.1, BOD]

Basis Discussion: The PCJ is used as the normal process control system. The PCJ allows remote operator control and monitoring of the RLD process (e.g., provision for process level, temperature, pressure, along with the ability to control and monitor pumps, motors, and valves to operate the RLD).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify that required specifications (related to PCJ interface) are included in MRs used to procure instruments with no active safety functions.	

3.9.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.9.4.1 Accessibility for Calibration, Testing, and Inspection

Requirement: HLW-RLD system shall provide the capability to access and perform remote (in cell) and direct calibration (out cell) and periodic functional testing, and inspections of equipment and components during normal operation. [Sections 6.7, 8.1.2, 9.12, 11.3.2.2, 12.6.3, BOD] [Section 9.1, 11.16, ORD] [Section III.10.C.5.c.iii, DWP WA7890008967]

Basis Discussion: Personnel exposure while performing calibration, testing, or inspection should be ALARA. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design for configuration that will facilitate access and performance of remote (in cell) and direct calibration (out cell), periodic functional testing, and inspections of equipment and components during normal operation.	May be documented in an assessment/evaluation.

3.9.4.2 Instrumentation Panels Location

Requirement: HLW-RLD instrumentation and detectors that require maintenance shall be located outside the C3 contaminated areas. However, transducer panels housing liquid level systems and associated I/O, and pressure transducers, shall be located in C3 classified areas as a precaution against back-contamination. [Section 11.16, ORD]

Basis Discussion: Locating instrumentation panels in C2 or lower classified areas increases the components operating life and reduces operator exposure to highly contaminated areas.
[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to ensure that instrument panels (with the exception of transducer panels housing liquid and associated I/O, and pressure transducer) for the HLW-RLD are located in C2 or lower classified areas.	May be documented in an assessment/evaluation.

3.10 Relevant Codes and Standards

3.10.1 Codes of Record

Table 3-6 below identifies relevant external codes and standards applicable to the HLW-RLD design. Use of the *Engineering, Procurement, and Construction (EPC) Code of* Record, 24590-WTP-COR-MGT-15-00001 is typically invoked in the design process through the documents identified in Section 3.10.2. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from the Code of Record for allocation to SSCs.

In some cases, the expected means of verification may be established on the basis of tests or other criteria required by the codes and standards. This does not necessarily include verification or testing more appropriately defined in the procurement of individual sub-systems or components, or verification or testing that is a routine activity defined by specifications and/or procedures used by construction and startup.

Table 3-6 HLW-Radioactive Liquid Waste Disposal System Applicable Codes and Standards

Implementing Codes and Standards: **[24590-WTP-COR-MGT-15-00001, Rev 0, Engineering, Procurement, and Construction (EPC) Code of Record]**
API STD-610, *Centrifugal Pumps for Petroleum, Heavy Duty Chemical, and Gas Service*
API STD-620, *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
AWS D1.1/D1.1M, *Structural Welding Code – Steel*
AWS D1.6, *Structural Welding Code - Stainless Steel*
WAC 173-303, *Washington Administrative Code - Dangerous Waste Regulations*
ANSI/AISC N690-1994, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*[2]
ANSI/ANS 58.8-1994, *Time Response Design Criteria for Safety-Related Operator Actions*[2]
ANSI/ANS 58.9-1981, *Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems*[2]
ANSI/ISA-67.04.01-2006, *Setpoints for Nuclear Safety-Related Instrumentation*, as tailored in Appendix C of the SRD[2]
ASME B31.3-1996, *Process Piping*, as tailored in Appendix C of the SRD[2]
ASME Section VIII, Divisions 1 & 2, *Boiler and Pressure Vessel Codes, Rules for Construction of Pressure* Vessels, as tailored in Appendix L of the SRD[1,2]
DOE-STD-1020-94 (Change 1 1996), *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*[2]
IEEE 323-1983, *Qualifying Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix C of the SRD*[2]
IEEE 338-1987, *Criteria for Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*, as tailored in Appendix C of the SRD[2]
IEEE 344-1987 (R1993), *Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,* as tailored in Appendix C of the SRD[2]
IEEE 379-1994, *Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems,* as tailored in Appendix C of the SRD[2]
IEEE 384-1992, *Standard Criteria for Independence of Class 1E Equipment and Circuits*, as tailored in Appendix C of the SRD[2]
IEEE 497-2002, *Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations* as tailored in Appendix C of the SRD[2]
IEEE 1023-1988, *IEEE Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations*[2]
ISA-S84.01-96, *Application of Safety Instrumented Systems for the Process Industries*[2]
NFPA 70-1999, *National Electrical Code*[2]
NFPA 69-2002, *Standard on Explosion Prevention Systems*, as tailored in Appendix C of the SRD[2]
NFPA 801-2003, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, as tailored in Appendix C of the SRD[2]
UBC 1997, *Uniform Building Code,* as tailored in Appendix C of the SRD[1,2]
[1] The HLW-PDSA specifies that design of selected portions of the HLW-RLD system per this code or standard is a credited design feature to help ensure the robustness of the design in support of the nuclear safety hazards analysis and selection of controls. [2] This code or standard from the SRD applies to components of the HLW-RLD system that have a safety function

3.10.2 WTP Design Criteria, Design Guides, and General Specifications

This section identifies relevant discipline design criteria, guides, and general specifications applicable to the HLW-RLD. Use of these documents to develop the detailed design of SSCs is governed by engineering procedures. The majority of requirements contained within these documents is derived from external codes and standards or are specified methods and approaches to achieve standardization and consistency of design. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from these documents for tracing and verification, or to define how direction provided by these documents is applicable and allocated (or not) to individual SSCs.

Table 3-7 WTP Design Criteria, Guides, and General Specifications Applicable to HLW-RLD

Document Number	Title
Design Criteria Documents:	
24590-WTP-DC-M-06-001	Mechanical Systems Design Criteria
24590-WTP-DC-E-01-001	Electrical Design Criteria
24590-WTP-DC-E-06-002	Design Criteria for Independence of Safety Equipment and Circuits
24590-WTP-DC-ENG-06-001	Design Criteria for Environmental and Natural Phenomena Hazard Qualification of Structures Systems and Components
24590-WTP-DC-PS-01-001	Pipe Stress Design Criteria Including "Pipe Stress Criteria" and "Span Method Criteria"
24590-WTP-DC-PS-01-002	Pipe Support Design Criteria
24590-WTP-DC-PS-03-001	Jumper Stress Design Criteria
24590-WTP-DC-ST-04-001	Seismic Analysis and Design Criteria
Design Guides:	
24590-WTP-GPG-ENG-004	Design Guide Pipe Stress, Pipe Layout, and Support Spacing
24590-WTP-GPG-ENG-005	Engineering Design Guide for Pipe Support
24590-WTP-GPG-ENG-033	Evaluation for Seismic Interaction Effects
24590-WTP-GPG-ENG-086	Equipment Environmental Qualification
24590-WTP-GPG-ENG-0094	Pipe Design Work Process
24590-WTP-GPG-ENG-0099	Design Verification of Plant Design Deliverables
24590-WTP-GPG-ENG-0103	Equipment Seismic Qualification
24590-WTP-GPG-ENG-0109	Accessibility Review of Equipment and Components
24590-WTP-GPG-ENG-0118	Piping Component Stock Codes
24590-WTP-GPG-ENG-0119	Isometric Drawings Production
24590-WTP-GPG-ENG-0123	Disposition of Hard to Reach Spools
24590-WTP-GPG-ENG-0127	Processing Engineering Calculations
24590-WTP-GPG-ENG-0129	Waste Acceptance Impacting Determination
24590-WTP-GPG-ENG-0130	Waste Acceptance Impacting Item Qualification Plan
24590-WTP-GPG-ENG-0141	WTP Radiation Damage Thresholds for Non-Metallic Materials
24590-WTP-GPG-ENG-0144	Piping Interface with Flexible Equipment-Stress Analysis Design Guide

Table 3-7 WTP Design Criteria, Guides, and General Specifications Applicable to HLW-RLD

Document Number	Title
24590-WTP-GPG-ENG-0145	SC-IIIE Piping - Stress Analysis Design Guide
24590-WTP-GPG-ENG-0146	Piping Coating System Selection Guide
24590-WTP-GPG-ENG-0150	Plant Design/Mechanical Systems Equipment Interfaces: Terminal End Equipment
24590-WTP-GPG-ENG-0153	Safety Instrumentation - Independent Protection Layer Identification
24590-WTP-GPG-ENG-0159	Single Failure Analysis Process for Mechanical, HVAC, and Control Systems
24590-WTP-GPG-ENG-0161	Technical Requirements Management
24590-WTP-GPG-ENG-0165	Pipe Stress and Supports Confirmation
24590-WTP-GPG-J-005	Control Systems Interfaces
24590-WTP-GPG-J-014	Control Systems Design Process Guide
24590-WTP-GPG-J-015	Safety Instrumented System Implementation
24590-WTP-GPG-J-016	Control Valve Sizing
24590-WTP-GPG-J-017	WTP Seismic Category Application to C&I Systems
24590-WTP-GPG-J-0057	Setpoint Calculations
24590-WTP-GPG-M-002	Hydraulic Seals
24590-WTP-GPG-M-005	Ejectors (Jet Pumps) for Liquid Slurry Pumping
24590-WTP-GPG-M-009	Jet Pumps (Ejectors) for Vacuum Generation
24590-WTP-GPG-M-011	Pipe Sizing for Compressible Flow
24590-WTP-GPG-M-012	Pump Net Positive Suction Head
24590-WTP-GPG-M-013	Plant Wash System Design
24590-WTP-GPG-M-017	Design Parameters & Test Pressures for Equipment & Piping
24590-WTP-GPG-M-019	Vessel Sizing
24590-WTP-GPG-M-022	Liquid and Vapor Line Sizing By Formula
24590-WTP-GPG-M-023	Other Losses in Piping Systems
24590-WTP-GPG-M-027	Recommended Slopes for Piping Systems
24590-WTP-GPG-M-028	Vent, Drain, and Root Valve Sizing and Selection for Piping Systems
24590-WTP-GPG-M-032	Vessel Overflow and Gravity Line Sizing
24590-WTP-GPG-M-036	Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts
24590-WTP-GPG-M-047	Preparation of Corrosion Evaluations
24590-WTP-GPG-M-050	Pressure Vessel and Heat Exchanger Design
24590-WTP-GPG-M-052	Specifying Design Cycles for Equipment and Piping
24590-WTP-GPG-M-0058	Minimum Flow Velocity for Slurry Lines
24590-WTP-GPG-M-0059	Avoiding Chemical Line Plugging - Plant Design Considerations
24590-WTP-GPG-M-0061	Vessel Structural Analysis and ASME Section VIII Evaluation

Table 3-7 WTP Design Criteria, Guides, and General Specifications Applicable to HLW-RLD

Document Number	Title
24590-WTP-GPG-P-0003	Jumper Design Guide
24590-WTP-GPG-PR-004	Preparation of Process Corrosion Data Sheets
24590-WTP-GPG-PL-002	Plant Design Material Control Guide
24590-WTP-GPG-SRAD-001	Design Guide for ALARA
Specifications:	
24590-WTP-3PS-FB01-T0001	Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment and Tanks
24590-WTP-3PS-G000-T0015	Engineering Specification for Environmental Qualification of Mechanical Equipment
24590-WTP-3PS-JQ00-T0004	Engineering Specification for Management of Supplier Software
24590-WTP-3PS-JQ06-T0005	Engineering Specification for Environmental Qualification of Control and Electrical Systems and Components
24590-WTP-3PS-JQ07-T0001	Engineering Specification for Instrumentation for Package Systems
24590-WTP-3PS-MCE0-T0002	Engineering Specification For Process Ejector/Eductor
24590-WTP-3PS-MPC0-T0002	Engineering Specification for General Centrifugal Pumps to Meet Requirements of ASME B73.1M-2001 and ASME B73.2M-2003 for Commercial (CM) Components
24590-WTP-3PS-MPC0-T0003	Engineering Specification for Sealless Centrifugal Pumps to Meet Requirements of API Standard 685, First Edition, for Quality Level Q
24590-WTP-3PS-MPPD-T0001	Engineering Specification for Air-operated Diaphragm Pumps
24590-WTP-3PS-MUMI-T0002	Engineering Specification for Low Voltage Induction Motors
24590-WTP-3PS-MVB2-T0001	Engineering Specification for Welding of Pressure Vessels, Heat Exchangers and Boilers
24590-WTP-3PS-MV00-T0001	Engineering Specification for Pressure Vessel Design and Fabrication
24590-WTP-3PS-MV00-T0002	Engineering Specification for Seismic Qualification Criteria for Pressure Vessels
24590-WTP-3PS-MV00-T0003	Engineering Specification for Pressure Vessel Fatigue Analysis
24590-WTP-3PS-SS00-T0001	Engineering Specification for Welding of Structural Carbon Steel
24590-WTP-3PS-SS00-T0002	Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Structural Stainless Steel
24590-WTP-3PS-G000-T0002	Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication.

4 System Description

This section summarizes design output information, describing the current design and the operational and maintenance aspects of the system. The information provided below does not contain design requirements and should not be used as design input. The description of the current design contained in this section may not fully align with design requirements. This is acceptable within the context of this document. Areas of misalignment are to be resolved through appropriate mechanisms and the SDD updated to reflect changes made to the design. Changes to the descriptive text will be made following the changes to the lower tiered engineering documents.

The HLW-RLD system receives effluents from the HLW melter offgas treatment process system (HOP), the HLW canister decontamination handling system (HDH), the HLW melter cave support handling system (HSH), off-spec streams from the HLW nonradioactive liquid waste disposal system (NLD), radioactively contaminated blowdown from the plant cooling water system (PCW), sample line flushes from the autosampling (ASX) system, and periodic plant and vessel washes within the HLW Facility. Various operations such as neutralization, mixing, and sampling of the effluent are performed by the system as required. The effluents are collected in various sumps throughout the HLW Facility, and periodically transferred to the PT Facility's plant wash and disposal system (PWD), where the waste is recycled into the process or transferred to the Liquid Effluent Retention Facility/Effluent Treatment Facility (LERF/ETF) for final treatment and disposal.

The HLW-RLD system includes vessels, piping, pumps, ejectors and instrumentation. The vessels include the acidic waste vessel (RLD-VSL-00007), the plant wash and drains vessel (RLD-VSL-00008), and the offgas drains collection vessel (RLD-VSL-00002). The major components (i.e., RLD vessels) of the HLW-RLD system are located in the wet process cell (black cell), room H-B014.

4.1 Configuration Information

4.1.1 Description of System, Subsystems, and Major Components

The HLW-RLD system receives, stores, and transfers effluents from various sources in the HLW Facility. The major effluent contributors during normal operations are:

- The acidic waste vessel (RLD-VSL-00007) is designed to collect effluents from the SBS (HOP-SCB-00001/2), the SBS condensate receiver vessels (HOP-VSL-00903/4), the waste neutralization vessel (HDH-VSL-00003), the decontamination tank for melter cave 1 and melter cave 2 (HSH-TK-00001 and HSH-TK-00002), sampler return (ASX-SMPLR-00028), PWD rack drains (PWD-RK-00032), and transfers from the plant wash and drains vessel (RLD-VSL-00008).
- The plant wash and drains vessel (RLD-VSL-00008) is designed to collect effluents from C3/C5 area sumps, the SBS (HOP-SCB-00001/2) (backup to RLD-VSL-00007), the waste neutralization vessel (HDH-VSL-00003) (backup to RLD-VSL-00007), the HSH (HSH-TK-00001/2), off-spec effluent from NLD-TK-00006, C3 workshop area decontamination booth and glove box drains, PWD rack drains, suspect active effluent from the plant cooling water system (PCW), transfers from the acidic waste vessel (RLD-VSL-00007), and the emptying ejectors of HFP-VSL-00001/2/5/6. *Use of HFP vessel emptying ejectors is restricted to decommissioning of vessel or facility*.
- The offgas drains collection vessel (RLD-VSL-00002) receives condensate from the low points in the main offgas ducts downstream of the high efficiency mist eliminators (HEMEs) (HOP-HEME-00001A/B and HOP-HEME-00002A/B); condensate from the low points in the main pulse jet ventilation system (PJV) header; and plant wash from PWD-RK-00032 for level makeup to assure a hydraulic seal. Collected effluents are transferred to the plant wash and drains vessel (RLD-VSL-00008) or the acidic waste vessel (RLD-VSL-00007).

The effluents stored in RLD-VSL-00007/8 are transferred by centrifugal pumps (RLD-PMP-00018 or RLD-PMP-00019) to the pretreatment HLW effluent transfer vessel (PWD-VSL-00043) or the pretreatment ultimate overflow vessel (PWD-VSL-00033); both vessels are located in the Pretreatment Facility. The contents in RLD-VSL-00007/8 may be sampled prior to being transferred to the Pretreatment Facility.

4.1.1.1 Acidic Waste Vessel (RLD-VSL-00007)

The acidic waste vessel (RLD-VSL-00007) is designed to collect effluents from the SBS (HOP-SCB-00001/2), the SBS condensate receiver vessels (HOP-VSL-00903/4), the waste neutralization vessel (HDH-VSL-00003), and the decontamination tanks for melter cave 1 and melter cave 2 (HSH-TK-00001/2).

Normally, transfers from the acidic waste vessel (RLD-VSL-00007) are to the pretreatment HLW effluent transfer vessel (PWD-VSL-00043). If vessel PWD-VSL-00043 is full, then the contents of RLD-VSL-00007 are routed to the pretreatment ultimate overflow vessel (PWD-VSL-00033).

The acidic waste vessel has an inside diameter of 13 feet and a tangent (shell) height of 15.5 feet; it is constructed of AL-6XN (6-moly) stainless steel, and is located on the south side of the wet process cell (WPC). The maximum operating volume of the vessel is 15,321 gallons and the total volume of the vessel is 18,051 gallons. The vessel design and construction is in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division I. The vessel is fitted with pressure, level, and temperature instruments. The level instruments are used to maintain the vessel level within the acceptable operating range, and include permissives and interlocks to preclude effluent transfer to and from the vessel when the level is outside of the normal operating range.

In the unlikely event of an overflow, vessel RLD-VSL-00007 overflows to the WPC sump (HCP-SUMP-00001). Vessel RLD-VSL-00008 also overflows to HCP-SUMP-00001. The overflow lines from both vessels (RLD-VSL-00007/8) are hard piped from the vessels where they are joined into a common overflow line down into HCP-SUMP-00001; a seal loop is included in the overflow line to prevent WPC air from entering the vessels and to prevent escape of vapors, fumes, or other emissions. The seal loop is equipped with level instrumentation and receives DIW makeup water via a PWD connection, to ensure a column of water in the line. This column prevents WPC air from entering the vessel and eventually adding to the HOP system load. In addition, the vessels overflow lines provide a secondary function to prevent vessel pressurization upon blockage of the PVV system.

Vessel RLD-VSL-00007 is equipped with four pulse jet mixers (PJM) (RLD-PJM-00005, RLD-PJM-00006, RLD-PJM-00007 and RLD-PJM-00008); the PJMs provide mixing during normal operations, when there is sufficient liquid present in the vessel.

The vessel is also equipped with a wash ring to provide plant wash water with capability to add nitric acid. Connection for nitric acid requires the installation of a removable spool piece; a blind flange is installed during normal operations. The wash ring may also be used to add sodium hydroxide from the SHR system for pH control.

4.1.1.2 Plant Wash and Drains Vessel (RLD-VSL-00008)

The plant wash and drains vessel (RLD-VSL-00008) is designed to collect effluents from C3/C5 area sumps, the SBS (HOP-SCB-00001/2), the waste neutralization vessel (HDH-VSL-00003), the decontamination tank for melter cave 1 and melter cave 2 (HSH-TK-00001/2), off-spec effluent from NLD-TK-00006, decontamination booth/glove box drain, PWD rack drains, and suspect active effluent from PCW.

During decontamination and decommissioning activities, the HFP steam ejectors located in HFP-VSL-00001/2/5/6 may be used to transfer the HFP-VSL-00001/2/5/6 contents to RLD-VSL-00008. Steam supply to the HFP-VSL-00001/2/5/6 ejectors is isolated during normal operations with a welded cap to prevent transfer of undiluted waste from the vessels to RLD-VSL-00008. Connection of the steam supply also requires the fabrication and installation of a spool piece.

The plant wash and drains vessel has an inside diameter of 13 feet and a tangent (shell) height of 15.5 feet; it is constructed of AL-6XN (6-moly) stainless steel, and is located on the south side of the WPC. The vessel design

and construction is in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division I. The maximum operating volume of the vessel is 15,321 gallons and the total volume of the vessel is 18,051 gallons. The vessel is also fitted with pressure, level, and temperature instruments. The level instruments are used to maintain the vessel level within the acceptable operating range, and include permissives and interlocks to preclude effluent transfer to and from the vessel when the level is outside of the normal operating range.

In the unlikely event of an overflow, vessel RLD-VSL-00008 overflows to the WPC sump (HCP-SUMP-00001). Vessel RLD-VSL-00007 also overflows to HCP-SUMP-00001. The overflow lines from both vessels (RLD-VSL-00007/8) are hard piped from the vessels to a tie where they are joined into a common overflow line down into HCP-SUMP-00001; a seal loop is included in the overflow line to prevent WPC air from entering the vessels and to prevent escape of vapors, fumes, or other emissions. The seal loop is equipped with level instrumentation and a PWD make-up water connection to ensure a column of water in the line. This column prevents WPC air from entering the vessel and eventually adding to the HOP system load. In addition, the vessel overflow lines provide a secondary function to prevent vessel pressurization upon blockage of the PVV system.

Vessel RLD-VSL-00008 is equipped with four PJMs (RLD-PJM-00001, RLD-PJM-00002, RLD-PJM-00003 and RLD-PJM-00004); the PJMs provide mixing during normal operations, when there is sufficient liquid present in the vessel.

The vessel is also equipped with a wash ring to provide plant wash water with capability to add nitric acid. Connection for nitric acid requires the installation of a removable spool piece; a blind flange is installed during normal operations.

Spilled/leaked liquids and cleanup decontamination waste from in-cell/cave liners, walls, equipment, and controls are collected in HLW sumps and sent to RLD-VSL-00008, where the contents can be sampled and transferred to the PT Facility for further processing.

4.1.1.3 Offgas Drains Collection Vessel (RLD-VSL-00002)

The offgas drains collection vessel (RLD-VSL-00002) is designed to receive condensate from the low points in the main offgas ducts downstream of the HEMEs (HOP-HEME-00001A/B and HOP-HEME-00002A/B); condensate from the low points in the main PJV header; and plant wash for level makeup to assure a hydraulic seal. RLD-VSL-00002 contents may be transferred to either RLD-VSL-00007 or RLD-VSL-00008.

The vessel is equipped with a wash ring to provide plant wash water with capability to add nitric acid. Connection for nitric acid requires the installation of a removable spool piece; a blind flange is installed during normal operations. The wash ring may also be used to add sodium hydroxide from the SHR system for pH control.

Drain lines discharging into RLD-VSL-00002 must be dipped below the liquid level in the vessel to maintain a static water column in the drain line that balances the pressure differential between the offgas drains collection vessel and the offgas systems to provide a hydraulic seal and to prevent the spread of contamination. In order to ensure the drain lines remain below the liquid level, makeup water from the plant wash system can be added to the vessel, via the wash ring, to compensate for evaporation when condensation occurring in the offgas system is not sufficient to keep up with the evaporation rate.

The offgas drains collection vessel has an inside diameter of 3.5 feet and a tangent (shell) height of 4 feet, is constructed of 316 stainless steel, and is located on the north side of the WPC. The maximum operating volume of the vessel is 260 gallons and the total volume of the vessel is 334 gallons.

The vessel is fitted with pressure, level, and temperature instruments. The level indicator is used to maintain the vessel level within the acceptable operating range. A high-high level interlock ensures PWD rack demin water makeup valve is closed upon high-high level detection, to reduce the likelihood of vessel overflow.

In the unlikely event of an overflow, the offgas drains collection vessel overflows to RLD-SUMP-00001. The sump is then emptied into RLD-VSL-00008 via steam ejector RLD-EJCTR-00052A/B. In addition, the vessel overflow line provides a secondary function to prevent vessel pressurization upon blockage of the PVV system.

Note: During RLD re-design Phase II, the discharge of one of the steam ejectors will be routed to RLD-VSL-00007 rather than both discharging to RLD-VSL-00008. This description will be updated following revision of 24590-HLW-M6-RLD-00014.

The offgas drains collection vessel contents are transferred by steam ejector RLD-EJCTR-00020A to RLD-VSL-00008 or by RLD-EJCTR-0020B to RLD-VSL-00007. The contents of the offgas drains collection vessel are sampled as part of the plant wash and drains vessel contents, or the acidic waste vessel RLD-VSL-00007 contents, before being transferred to vessels PWD-VSL-00043 or PWD-VSL-00033.

4.1.1.4 Breakpots

Breakpots are utilized throughout the RLD system so that the effluent being transferred is gravity drained instead of pumped in order to simplify the equipment used.

Note: At the time of issuance of this revision, the use of breakpots in the HLW-RLD system is being re-evaluated and will result in their re-purposing and relocation. Detailed description of breakpots will be included in a future revision of this SDD.

4.1.1.5 Transfer Pumps

The HLW-RLD transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) are centrifugal pumps used to transfer effluents from RLD-VSL-00007 and RLD-VSL-00008 to vessels PWD-VSL-00033 or PWD-VSL-00043, which are located in the Pretreatment Facility. Each transfer pump has sufficient capacity to ensure the HLW-RLD system can support daily glass production. The RLD transfer pumps also deliver samples from RLD-VSL-00007 and RLD-VSL-00008 to autosampler ASX-SMPLR-00028 for characterization of the effluents that are transferred to the Pretreatment Facility. The transfer pumps are located in individual bulges that are outside and adjacent to the WPC; the bulges provide shielding and confinement but are also accessible to support maintenance/replacement activities. RLD-PMP-00018 is located in RLD-BULGE-00008 and RLD-PMP-00019 is located in RLD-BULGE-00009.

In addition to transfers between RLD-VSL-00007/8 and PWD-VSL-00033/43 and delivering samples to ASX-SMPLR-00028, the transfer pumps are designed to support the following:

- RLD-VSL-00007/8 recirculation (optional feature)
- RLD system flush using DIW pumps in series and aligned to the suction of RLD-PMP-00018/19
- Transfers between RLD-VSL-00007 and RLD-VSL-00008

4.1.1.6 Steam Ejectors

Steam ejectors are used throughout the RLD system for transfers from vessels and sumps in order to minimize maintenance. The steam ejectors use high-pressure steam from the high pressure steam system (HPS) to operate. Steam ejectors are used to transfer the effluents from the offgas drains collection vessel (RLD-VSL-00002). They are also used in various RLD sumps throughout the areas that have minimal or no maintenance capability (i.e., C5

areas). Steam ejector drive lines are purged with instrument air before and after each transfer to prevent steam collapse causing reverse flow of the contents of a sump into the steam supply line, and to facilitate removal of condensate from the lines. Ejectors from HFP are used only during decontamination and decommissioning, as discussed in Section 4.1.1.2.

Some of the steam ejectors include jumper connections. Jumpers are removable and were used when needed to prevent interferences with other facility features.

4.1.1.7 Diaphragm Pumps

Diaphragm pumps are used in the C2 and C3 area sumps for transfers to the plant wash and drains vessel (RLD-VSL-00008). The diaphragm pumps use instrument air from the instrument air system (ISA) to operate. Diaphragm pumps are only used in accessible areas (C2/C3) because they require regular maintenance. The sump transfer pumps will need to be periodically maintained to ensure they are working adequately.

4.1.1.8 Sumps

Various sumps throughout the HLW Facility (summarized in Table 4-1 below) collect cell washes, spills/leaks, and decontamination waste from in-cell/cave liners, walls, equipment and controls and then discharge their contents into the plant wash and drains vessel (RLD-VSL-00008). Discharges from the vessels are routed to the plant wash and drains vessel by either a steam ejector (Section 4.1.1.6) or a diaphragm pump (Section 4.1.1.7). Some of the HSH sumps (HSH-SUMP-00003/7/8/9) contain removable baskets in them to prevent oversize material from entering the RLD system. These baskets can be removed via a remotely operated manipulator. Selected sumps contain level indicators that have the capability to detect spill/leak rates into the sumps of at least 0.1 gallons per hour in order to alert operators so that the spill/leak can be removed within 24 hours (see Section 4.1.6.1.2.2).

Table 4-1 HLW Facility Sumps Discharging to RLD

Sump	Location	Room	Dimensions	Size
HDH-SUMP-00001	Canister Rinse Tunnel	H-B039B	TBD	TBD
HDH-SUMP-00002	Canister Rinse Trolley Maintenance Room	H-B039A	TBD	TBD
HDH-SUMP-00003	Canister Decon Cave	H-B035	TBD	TBD
HDH-SUMP-00004	Canister Decon Cave Crane Maintenance Room	H-0313A	TBD	TBD
HEH-SUMP-00001	Canister Storage Crane Maintenance Room	H-0313B	TBD	TBD
HFH-SUMP-00001	Filter Cave Crane Maintenance Room	H-0201	TBD	TBD
HMH-SUMP-00001	Melter 1 Cave C2/C3 Air Lock	H-0116A	TBD	TBD
HMH-SUMP-00002	Melter 1 Cave C3/C5 Air Lock	H-0116B	TBD	TBD
HMH-SUMP-00003	Melter 2 Cave C3/C5 Air Lock	H-0105B	TBD	TBD
HMH-SUMP-00004	Melter 2 Cave C2/C3 Air Lock	H-0105A	TBD	TBD
HOP-SUMP-00002	Offgas Absorber Room	H-B001B	TBD	TBD
HPH-SUMP-00001	Canister Handling Cave	H-0136	TBD	TBD
HPH-SUMP-00002	Canister Handling Crane Decontamination	H-0329	TBD	TBD
HPH-SUMP-00005	Canister Handling Cave	H-0136	TBD	TBD
HRH-SUMP-00001	Canister Import Tunnel	H-B045	TBD	TBD
HSH-SUMP-00001	Melter 1 Crane Maintenance Room	H-0309	TBD	TBD
HSH-SUMP-00002	Melter 1 Crane Decontamination Room	H-0310	TBD	TBD
HSH-SUMP-00005	Melter 2 Crane Decontamination Room	H-0304	TBD	TBD
HSH-SUMP-00006	Melter 2 Crane Maintenance Room	H-0303	TBD	TBD
HSH-SUMP-00008	Melter 1 Cave Equipment Decontamination Pit	H-0310A	TBD	TBD
HSH-SUMP-00009	Melter 2 Cave Equipment Decontamination Pit	H-0304A	TBD	TBD

Sump	Location	Room	Dimensions	Size
RLD-SUMP-00001	Wet Process Cell	H-B014	TBD	TBD
RWH-SUMP-00001	Drum Tunnel	H-B015	TBD	TBD
RWH-SUMP-00002	Drum Decon Room	H-0126B	TBD	TBD
RWH-SUMP-00003	Drum Crane Maintenance Room	H-0126A	TBD	TBD
RWH-SUMP-00004	Drum Trolley Maintenance Room	H-B029A	TBD	TBD
RWH-SUMP-00005	Drum Tunnel	H-B015	TBD	TBD
RWH-SUMP-00006	Drum Tunnel	H-B015	TBD	TBD
RWH-SUMP-00007[1]	Drum Cask Room	H-B028	TBD	TBD
RWH-SUMP-00008	Drum Cask Tunnel	H-B028A	TBD	TBD

Notes:

1. RWH-SUMP-00007 is not provided with an emptying ejector or diaphragm pump. This sump does not receive accidental or planned releases of liquid.

4.1.1.9 Pulse Jet Mixer

The HLW-RLD system utilizes pulse jet mixers (PJMs) to provide mixing in RLD-VSL-00007 and RLD-VSL-00008. PJMs have been chosen as the means for tank/vessel mixing because there are no moving parts and their design life is 40 years. They are constructed of AL-6XN for corrosion resistance.

PJMs are built around the principle of using air to move radioactive liquids and sludges. Due to the absence of moving parts and simplification of equipment, PJMs are virtually maintenance-free. Maintenance is required on the valves and instrumentation that deliver the air to the PJMs; however, this equipment is located in areas accessible for maintenance/repair.

Four PJMs are located in both the acidic waste vessel and the plant wash and drains vessels (RLD-VSL-00007/8). The PJMs are evenly spaced on a 2/3 radius around the vessel. The jet pump pairs for the PJMs are located above the vessel in the wet process cell and the PJM controllers are located outside the wet process cell in the RLD racks for service. Effluent is drawn into a pulse tube, and then pressurized air forces it back into the vessel through a 4-inch nozzle. The motion of the liquid into and out of the pulse tube provides the agitation. The pressurized air is exhausted air to the PJV system prior to its release to the environment.

Connections from the DIW system are provided for flushing the air link lines (pipe running from the JPP to the PJM) in order to keep them from being clogged, and to sweep radioactive contamination from the lines.

4.1.1.10 Headers, Manifolds, and Pipelines

There are several headers in the RLD system, which convey discharges from HLW sump diaphragm pump and ejector to the plant wash and drains vessel (RLD-VSL-00008) or the acidic waste vessel (RLD-VSL-00007). After a leak, spill, or wash down, liquid drains towards a sump from where it is transferred to RLD-VSL-00007 or RLD-VSL-00008 by a sump ejector or sump diaphragm pump via a header. In addition, the sump transfer headers are connected to plant wash discharges in order to facilitate flushing of the header after use. Nitric acid may be added to the stream in order to assist the cleaning and flushing of the header, which is designed to be self-draining with no pockets.

Piping is designed to be self-draining without pockets or free-draining (with low point drains). Air and demineralized water lines valves are located on the service racks in order to facilitate testing of isolated portions of the RLD system.

Overflow lines are designed to prevent pressurization of the vessels and manifolds.

Floor drains/catch areas and hard piping (instead of sumps and sump transfer ejectors/pumps) are utilized to transport effluent leaks, spills, or wash down liquids to a sump in cases where there is no space for a sump, or to increase the minimum liquid leak detection rate to an acceptable value.

Piping manifolds are utilized to convey effluent transfers from various sources (e.g., sumps, HSH tanks) to the plant wash and drains vessel or the acidic waste vessel. Effluents are delivered to the manifolds from which they gravity drain into RLD-VSL-00008 or RLD-VSL-00007. Piping manifolds that receive effluents from steam ejectors are fitted with temperature elements that detect when a steam ejector is running without a pumped liquid; the associated temperature indicators are interlocked to shut off the transfer ejectors in order to protect the piping from the elevated temperatures.

4.1.2 Boundaries and Interfaces

RESERVED

4.1.3 Physical Layout and Location

Refer to: *24590-HLW-P1-P01T-00001, HLW Vitrification Building General Arrangement Plan at Elevation -21'0"; 24590-HLW-P1-P01T-00008, HLW Vitrification Building General Arrangement Sections A-A B-B & C-C; and 24590-HLW-P1-P23T-00009, HLW Vitrification Building Equipment Location Plan El. -21'0" / Area 9.*

The primary HLW RLD equipment is located at the following elevation and rooms within the HLW Vitrification Building.

Tag Number	Elevation	Room
RLD-VSL-00007	EL - 21' 0"	H-B014
RLD-VSL-00008	EL - 21' 0"	H-B014
RLD-VSL-00002	EL - 21' 0"	H-B014
RLD-PMP-00018	EL - 21' 0"	RLD-BULGE-00008
RLD-PMP-00019	EL - 21' 0"	RLD-BULGE-00009
RLD-BRKPT-00004	TBD	TBD
RLD-BRKPT-00007	TBD	TBD
RLD-BRKPT-00009	TBD	TBD

4.1.4 Principles of Operation

Refer to: *24590-HLW-M5-V17T-00007001, Process Flow Diagram HLW Vitrification Liquid Waste Effluent (System RLD)(Sheet 1); and 24590-HLW-M5-V17T-00007002, Process Flow Diagram HLW Vitrification Liquid Waste Effluent (System RLD)(Sheet 2).*

The acidic waste vessel (RLD-VSL-00007) receives transfers from the HOP, HSH and HDH systems. Transfers to PWD-VSL-00043 are performed when the batch is full or at the operator's discretion. When vessel PWD-VSL-00043 is full the contents of RLD-VSL-00007 are routed to PWD-VSL-00033. In the event of an overflow, both RLD-VSL-00007 and RLD-VSL-00008 overflow into HCP-SUMP-00001.

The plant wash and drains vessel (RLD-VSL-00008) receives intermittent flows from RLD-VSL-00002, various C3/C5 area sumps, off-spec effluent from NLD-TK-00006, C3 workshop area decontamination booth/glove box drains, PWD rack drains, and suspect active effluent from PCW. Transfers to PWD-VSL-00043 are done when

the RLD contains a full batch, or at the operator's discretion. When vessel PWD-VSL-00043 is full then the contents of RLD-VSL-00008 will be routed to PWD-VSL-00033.

As needed, operators direct to RLD-VSL-00008 the normal inflows that typically go to RLD-VSL-00007.

Sampling is performed via ASX-SMPLR-00028 to characterize the effluents before they are transferred to the PT Facility. The process liquid sample is transferred to ASX-SMPLR-00028 by RLD RLD-PMP-00018 or RLD-PMP-00019.

4.1.5 System Reliability Features

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4.1.6 System Control Features

The HLW-RLD system handles radioactively contaminated liquid waste for interim storage before transferring the effluents to the PT Facility. The system performs various operations, such as collection, transfer, neutralization (if required), mixing, and effluent sampling. Process effluents from HOP, HDH, HSH, out-of-specification streams, and periodic plant and vessel washes within the HLW Facility are collected and routed to the various storage vessels.

4.1.6.1 System Monitoring

4.1.6.1.1 Safety-Related System Monitoring

There are no safety-related instruments in the HLW-RLD system.

4.1.6.1.2 Non-Safety-Related System Monitoring

4.1.6.1.2.1 Vessel Instrumentation and Alarms

4.1.6.1.2.1.1 Vessel RLD-VSL-00008 Monitoring

Level monitoring is available to the operators to prevent overflows and to provide data on the effluent level in the vessel before the effluents are transferred. Level in RLD-VSL-00008 is measured by RLD-LI-3240 and RLD-LI-3241. Alarms are initiated by PCJ at the Low-Low and High-High setpoints. Interlocks are addressed in Sections 4.1.6.5.2.5 and 4.1.6.5.2.6.

Temperature and pressure indications are available to the operator to ensure the effluents within the vessels are maintained within the system specified operating range. Pressure (which is maintained by the HOP system) is measured by RLD-PI-3216, and temperature is measured by RLD-TI-3214.

4.1.6.1.2.1.2 Vessel RLD-VSL-00007 Monitoring

Level monitoring is available to the operators to prevent overflows and to provide data on the effluent level in the vessel before the effluents are transferred. Level in RLD-VSL-00007 is measured by RLD-LI-3152 and RLD-LI-3153. Alarms are initiated by PCJ at the Low-Low and High-High setpoints. Interlocks are addressed in Sections 4.1.6.5.2.5 and 4.1.6.5.2.6.

Temperature and pressure indications are available to the operator to ensure the effluents within the vessels are maintained within the system specified operating range. Pressure (which is maintained by the HOP system) is measured by RLD-PI-3151, and temperature is measured by RLD-TI-3115.

4.1.6.1.2.1.3 Vessel RLD-VSL-00002 Monitoring

Level monitoring is available to the operators to verify operation within the normal operating range. Level in RLD-VSL-00002 is measured by RLD-LI-3024. Alarms are initiated by PCJ at the Low-Low and High-High setpoints. The Low-Low level interlock is addressed in Sections 4.1.6.5.2.7.

Temperature and pressure indications are available to the operator to ensure the effluents within the vessels are maintained within the system specified operating range. Pressure (which is maintained by the HOP system) is measured by RLD-PI-3026 and temperature is measured by RLD-TI-3025.

4.1.6.1.2.2 Sumps Instrumentation and Alarms

Each sump in the RLD system has level indication that reports the sump liquid level to the PCJ system and allows the operator to monitor the level in the sump. Level indication is available to the operators to ensure that high liquid level or low liquid level in the sumps is detected and action is taken to prevent adverse consequences to the RLD system and the HLW facility.

Leak rate detection capability is also provided in selected sumps to identify spill/leak rates into the sumps of at least 0.1 gallons per hour in order to alert operators so that the spill/leak can be removed within 24 hours.

Sump level indicators, leak detection capability and alarm setpoints are summarized below.

Sump CTN	Level Indicator	Leak Rate Detection (Yes/No)	Alarm Setpoint (LL/L/H/HH)
HCP-SUMP-00001	RLD-LI-3014	Yes	TBD
HDH-SUMP-00001	RLD-LI-3416	Yes	TBD
HDH-SUMP-00002	RLD-LI-3418	Yes	TBD
HDH-SUMP-00003	RLD-LI-3413	Yes	TBD
HDH-SUMP-00004	RLD-LI-3801	TBD	TBD
HEH-SUMP-00001	RLD-LI-3802	TBD	TBD
HFH-SUMP-00001	RLD-LI-3201	TBD	TBD
HFP-SUMP-00002	RLD-LI-3803	Yes	TBD
HFP-SUMP-00005	RLD-LI-3853	Yes	TBD
HMH-SUMP-00001	RLD-LI-3310	TBD	TBD
HMH-SUMP-00002	RLD-LI-3309	TBD	TBD
HMH-SUMP-00003	RLD-LI-3359	TBD	TBD
HMH-SUMP-00004	RLD-LI-3360	TBD	TBD
HOP-SUMP-00002	RLD-LI-3205	TBD	TBD
HOP-SUMP-00003	RLD-LI-3102	Yes	TBD
HOP-SUMP-00008	RLD-LI-3172	Yes	TBD
HPH-SUMP-00001	RLD-LI-3411	Yes	TBD
HPH-SUMP-00002	RLD-LI-3405	TBD	TBD
HPH-SUMP-00003	RLD-LI-3409	Yes	TBD
HPH-SUMP-00004	RLD-LI-3459	TBD	TBD
HPH-SUMP-00005	RLD-LI-3403	Yes	TBD
HRH-SUMP-00001	RLD-LI-3401	TBD	TBD

Sump CTN	Level Indicator	Leak Rate Detection (Yes/No)	Alarm Setpoint (LL/L/H/HH)
HSH-SUMP-00001	RLD-LI-3311	TBD	TBD
HSH-SUMP-00002	RLD-LI-3308	TBD	TBD
HSH-SUMP-00003	RLD-LI-3805	Yes	TBD
HSH-SUMP-00005	RLD-LI-3358	TBD	TBD
HSH-SUMP-00006	RLD-LI-3361	TBD	TBD
HSH-SUMP-00007	RLD-LI-3855	Yes	TBD
HSH-SUMP-00008	RLD-LI-3333	Yes	TBD
HSH-SUMP-00009	RLD-LI-3383	Yes	TBD
RLD-SUMP-00001	RLD-LI-3215	Yes	TBD
RWH-SUMP-00001	RLD-LI-3807	TBD	TBD
RWH-SUMP-00002	RLD-LI-3204	TBD	TBD
RWH-SUMP-00003	RLD-LI-3203	TBD	TBD
RWH-SUMP-00004	RLD-LI-3202	TBD	TBD
RWH-SUMP-00005	RLD-LI-3810	TBD	TBD
RWH-SUMP-00006	RLD-LI-3813	TBD	TBD
RWH-SUMP-00008	RLD-LI-3521	TBD	TBD

4.1.6.1.2.2.1 Pump/Ejectors and Piping Instrumentation and Alarms

4.1.6.1.2.2.2 Manifold Temperature Monitoring

The effluent manifolds delivering effluent to RLD vessels have temperature monitoring, measured by the following temperature instruments: RLD-TI-3108, RLD-TI-3109, RLD-TI-3110, RLD-TI-3209, RLD-TI-3208, and RLD-TI-3302.

4.1.6.1.2.2.3 RLD-VSL-00007/8 Overflow Line Seal Loop Level Monitoring

Liquid level in the RLD-VSL-0007/8 overflow lines seal loop is measured by RLD-LI-3246 and is available to the operators to verify level is within the normal operating range. Seal loop makeup is addressed in Sections 4.1.6.2 and 4.1.6.3.

4.1.6.2 Control Capability and Locations

4.1.6.2.1 Safety-Related Control Capability and Locations

There are no safety-related control capabilities associated with the HLW-RLD system.

4.1.6.2.2 Non-Safety Related Control Capability and Locations

4.1.6.2.2.1 RLD-VSL-00007/8 Overflow Line Seal Loop Level Makeup

The operators have the capability to operate RLD-YV-3247 remotely to add seal loop makeup water, as needed. The overflow line discharges into HCP-SUMP-00001.

4.1.6.2.2.2 Sump Pump/Ejector Initiation

The operators have the capability to manually initiate or stop transfers from each individual sump that discharges to RLD-VSL-00007 or RLD-VSL-0008. Pump/ejector operation is initiated or stopped by remotely actuating the steam (for ejector) or compressed air (for diaphragm pumps) supply isolation valves. Refer to Table 1 of 24590-HLW-M6-RLD-00001002 (for RLD-VSL-00007) and 24590-HLW-M6-RLD-00002003 (for RLD-VSL-00008) for a list of these valves.

4.1.6.2.2.3 Routine Flushing Activities

The operators have the capability to routinely perform the following flushing activities via remotely controlled isolation valves:

Description/CTN	Rack CTN	Valve(s)
RLD line from RLD-VSL-00007 to ASX-SMPLR-00028	TBD	TBD
RLD line from RLD-VSL-00008 to ASX-SMPLR-00028	TBD	TBD
RLD line from ASX-SMPLR-00028 to RLD-VSL-00007	TBD	TBD
RLD line from ASX-SMPLR-00028 to RLD-VSL-00008	TBD	TBD
RLD line from RLD-PMP-00018 to PWD-VSL-00043	TBD	TBD
RLD line from RLD-PMP-00019 to PWD-VSL-00043	TBD	TBD
RLD line form RLD-PMP-00018 to PWD-VSL-00033	TBD	TBD
RLD line from RLD-PMP-00019 to PWD-VSL-00033	TBD	TBD
RLD line from RLD-PMP-00018 to RLD-VSL-00007	TBD	TBD
RLD line from RLD-PMP-00019 to RLD-VSL-00007	TBD	TBD
RLD line from RLD-PMP-00018 to RLD-VSL-00008	TBD	TBD
RLD line from RLD-PMP-00019 to RLD-VSL-00008	TBD	TBD
RLD-PJM-00001	TBD	TBD
RLD-PJM-00002	TBD	TBD
RLD-PJM-00003	TBD	TBD
RLD-PJM-00004	TBD	TBD
RLD-PJM-00005	TBD	TBD
RLD-PJM-00006	TBD	TBD
RLD-PJM-00007	TBD	TBD
RLD-PJM-00008	TBD	TBD
RLD-VSL-00002	TBD	TBD
RLD-VSL-00007	TBD	TBD
RLD-VSL-00008	TBD	TBD
RLD-VSL-00007 level detection bubbler lines (RLD-DT-3174/3175, RLD-LT-3152/3153)	TBD	TBD
RLD-VSL-00008 level detection bubbler lines (RLD-DT-3248/3249, RLD-LT-3240/3241)	TBD	TBD
Drain manifolds	TBD	TBD
Overflow manifolds	TBD	TBD

4.1.6.3 Automatic and Manual Actions

4.1.6.3.1 Safety Related Automatic and Manual Actions

There are no safety-related automatic or manual actions associated with the HLW-RLD system.

4.1.6.3.2 Non-Safety Related Automatic and Manual Actions

4.1.6.3.2.1 Seal Loop Level Makeup

When the level in the seal loop reaches the Low or High setpoint an alarm is initiated; operators can take action to remotely open or close RLD-YV-3247, as needed, to add or stop makeup water to the seal loop. If the level reaches the High-High setpoint, RLD-YV-3247 closes to preclude overfilling the seal loop.

4.1.6.3.2.2 Offgas Drains Collection Vessel Makeup (RLD-VSL-00002)

Plant operators may add makeup water from the plant wash system to RLD-VSL-00002, by opening RLD-YV-3023, to compensate for evaporation when condensation occurring in the offgas system is not sufficient to keep up with the evaporation rate. This ensures that the drain lines are dipped below the liquid level.

4.1.6.3.2.3 Transfer Pump Operation (RLD-PMP-00018/19)

Transfers from RLD-VSL-00007/8 using RLD-PMP-00018/00019 are manually initiated and terminated by the operator, except when prompted by interlocks, as discussed in Section 4.1.6.5.2.6.

4.1.6.3.2.4 Air Purging

RESERVED

4.1.6.4 Setpoints and Ranges

4.1.6.4.1 Safety Related Setpoints and Ranges

There are no safety-related setpoints associated with the HLW-RLD system.

4.1.6.4.2 Non-Safety Related Setpoints and Ranges

RESERVED

4.1.6.5 Interlocks, Bypasses, and Permissives

4.1.6.5.1 Safety Related Interlocks, Bypasses, and Permissives

There are no safety-related interlocks, bypasses, and permissives associated with the HLW-RLD system.

4.1.6.5.2 Non-Safety Related Interlocks, Bypasses, and Permissives

4.1.6.5.2.1 Sump Low Level Transfer Interlock

The HLW-RLD valves that isolate the steam/air supplied by the HPS or ISA systems –as applicable for the individual sump– to the transfer pump/ejector receive a closing signal from the PCJ system when the liquid level in the associated sump is at or below the Low setpoint. This interlock also closes HPS supply valves located on the steam rack headers, for those sumps that utilize steam ejectors. Isolating the transfer devices when effluent inventory is insufficient precludes damage to the associated equipment and piping.

4.1.6.5.2.2 Sump High Level Transfer Interlock

The HLW-RLD valves that isolate effluent discharges to HCP-SUMP-00001 and RLD-SUMP-00001 receive a closing signal from the PCJ system when the level in the associated sump exceeds the High setpoint.

The following is a list of sump level indicators and the valves they close.

Level Indicator CTN	Valve(s)
TBD	TBD

4.1.6.5.2.3 Sump High-High Level Transfer Interlock

The HLW-RLD valves that isolate PWD to the wash nozzles --used to rinse down the cell or cave liner in which the following sumps are located-- receive a closing signal from the PCJ system when the level in the associated sump exceeds the High-High setpoint:

HSH-SUMP-00002, HSH-SUMP-00003, HSH-SUMP-00005, HSH-SUMP-00007, HFP-SUMP-00002, HFP-SUMP-00005, HOP-SUMP-00003, HOP-SUMP-00008, and HCP-SUMP-00001

The following is a list of sump level indicators and the valves they close.

Level Indicator CTN	Valve(s)
TBD	TBD

4.1.6.5.2.4 Sumps/Vessels Transfer Manifold High-High Temperature Interlocks

The HLW-RLD valves that isolate the steam supplied by the HPS system to the sump/vessel transfer ejectors receive a closing signal from the PCJ system when the temperature in the associated transfer manifolds, as measured by the manifold temperature instruments, exceed the High-High temperature setpoint.

The following is a list of temperature indicators and the valves they close.

Temperature Indicator CTN	Valve(s)
RLD-TI-3108	RLD-YV-3236 and RLD-YV-3150
RLD-TI-3109	RLD-YV-3149 and RLD-YV-3237
RLD-TI-3110	RLD-YV-3147, RLD-YV-3148, RLD-YV-3501, RLD-YV-3502
RLD-TI-3209	RLD-YV-3238, RLD-YV-3239
RLD-TI-3208	RLD-YV-3021, RLD-YV-3022, RLD-YV-3233
RLD-TI-3302	RLD-YV-3806, RLD-YV-3316, RLD-YV-3317

4.1.6.5.2.5 Vessel RLD-VSL-00007/8 High-High Interlocks

The HLW-RLD valves listed in Table 1 of 24590-HLW-M6-RLD-00002003 receive a closing signal from the PCJ system when the level in RLD-VSL-00008, as measured by RLD-LI-3240 or RLD-LI-3241, exceeds the High-High setpoint.

Similarly, the HLW-RLD valves listed in Table 1 of 24590-HLW-M6-RLD-00001002 receive a closing signal from the PCJ system when the level in RLD-VSL-00007, as measured by RLD-LI-3152 or RLD-LI-3153, exceeds the High-High setpoint.

Isolation of these valves prevents sump pumps and ejectors from discharging to RLD-VSL-00007 or RLD-VSL-00008, as applicable, when the volume available is insufficient to accept the transfer.

RLD-PMP-00019 and RLD-PMP-00019 receive a stop signal from the PCJ system when the level in RLD-VSL-00008, as measured by RLD-LI-3240 or RLD-LI-3241, or the level in RLD-VSL-00007, as measured by RLD-LI-3152 or RLD-LI-3153, exceeds the High-High setpoint.

4.1.6.5.2.6 Vessel RLD-VSL-00007/8 Low-Low Interlocks

RLD-PMP-00018 and RLD-PMP-00019 receive a stop signal from the PCJ system when the level in RLD-VSL-00007, as measured by RLD-LI-3152 or RLD-LI-3153, is at or below the Low-Low setpoint.

A Low-Low signal from RLD-VSL-00008, as measured by RLD-LI-3240 or RLD-LI-3241, also results in a stop signal to RLD-PMP-00018 and RLD-PMP-00019.

These interlocks ensure (1) adequate heel volume in the vessel for proper operation of the PJMs, and (2) sufficient suction head available for proper transfer pump operation.

4.1.6.5.2.7 Vessel RLD-VSL-00002 Low-Low Level Interlock

Steam supply valves RLD-YV-3021 and RLD-YV-3022, which isolate the steam supplied by the HPS system to ejectors RLD-EJCTR-00020A and RLD-EJCTR-00020B, receive a closing signal from the PCJ system when the liquid level in RLD-VSL-00002, as measured by RLD-LI-3024, is at or below the Low-Low setpoint.

4.2 Operations

4.2.1 Initial Configuration (Pre-startup)

RESERVED

4.2.2 System Startup

RESERVED

4.2.3 Normal Operations

RESERVED

4.2.4 Off-Normal Operations

RESERVED

4.2.5 System Shutdown

RESERVED

4.2.6 Safety Management Programs and Administrative Controls

RESERVED

4.3 Testing and Maintenance

RESERVED

4.3.1 Temporary Configurations

RESERVED

4.3.2 TSR-Required Surveillances

RESERVED

4.3.3 Non-TSR Inspections and Testing

RESERVED

4.3.4 Maintenance

RESERVED

4.4 Supplemental Information

RESERVED

5 Sources, Bases, and Other References

5.1 Source/Basis References

Document Number	Rev	Title	Text Reference
24590-WTP-DB-ENG-01-001	3	Basis of Design	BOD
24590-WTP-RPT-OP-01-001	6	Operations Requirements Document	ORD
24590-WTP-PSAR-ESH-01-002-04	5J	Preliminary Documented Safety Analysis to Support Construction Authorization; HLW Facility Specific Information	PDSA - HLW Facility
24590-WTP-SRD-ESH-01-001-02	7F	Safety Requirements Document, Volume II	SRD
DE-AC27-01RV14136	N/A	DOE/BNI WTP Contract Mod No. 354, Section C - Statement of Work	WTP Contract
WA7890008967	N/A	Dangerous Waste Portion of RCRA Permit	DWP WA7890008967

5.2 Other References

Document Number	Rev	Title
24590-HLW-U0D-W16T-00001	1	HLW Room Environment Data Sheet
24590-HLW-N1D-RLD-00001	8	RLD-VSL-00007 (HLW) - Acidic Waste Vessel
24590-HLW-N1D-RLD-00002	5	RLD-BRKPT-00007 & RLD-BRKPT-00009 - (HLW) Acidic Wash Transfer Breakpot - Corrosion Evaluation
24590-HLW-N1D-RLD-00006	8	RLD-VSL-00008 (HLW) - Plant Wash and Drains Vessel
24590-HLW-N1D-RLD-00009	5	RLD-BRKPT-00004 (HLW) - Wash Effluent Breakpot
24590-HLW-N1D-RLD-00013	7	RLD-VSL-00002 (HLW) - Offgas Drains Collection Vessel
24590-WTP-3PS-JQ00-T0004	1	Management of Supplier Software
24590-WTP-3PS-JQ00-T0005	1	Management of Supplier Safety Software
24590-WTP-GPP-SQP-208	5	Plant Software Life Cycle Management
24590-WTP-M6-50-00008	3	P&ID Symbols and Legend (Sheet 8 of 8)
DOE-STD-1020-94	N/A	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
24590-WTP-RPT-PR-04-0001-01	A	WTP Process Corrosion Data – Volume 1
24590-WTP-RPT-PR-04-0001-02	0	WTP Process Corrosion Data – Volume 2
24590-WTP-RPT-PR-04-0001-03	0	WTP Process Corrosion Data – Volume 3
24590-WTP-RPT-PR-04-0001-04	A	WTP Process Corrosion Data – Volume 4
24590-WTP-RPT-PR-04-0001-05	0	WTP Process Corrosion Data – Volume 5
24590-WTP-RPT-PR-04-0001-06	0	WTP Process Corrosion Data – Volume 6

Document Number	Rev	Title
24590-HLW-RPT-ENV-09-001	2	Dangerous Waste Permit Secondary Containment Requirements for HLW Facility
24590-HLW-3ZD-30-00001	0	HLW Facility Design Description
24590-WTP-3DP-G04B-00092	0	System Verification

5.3 System Design Documents

Document Number	Title
Process Flow Diagrams	
24590-HLW-M5-V17T-00007001	Process Flow Diagram HLW Vitrification Liquid Waste Effluent (System RLD)(Sheet 1)
24590-HLW-M5-V17T-00007002	Process Flow Diagram HLW Vitrification Liquid Waste Effluent (System RLD)(Sheet 2)
24590-PTF-M5-V17T-00022002	Process Flow Diagram Pretreatment Plant Wash and Disposal System PWD
P&IDs	
24590-HLW-M6-RLD-00001001	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-VSL-00007 Process Lines.
24590-HLW-M6-RLD-00001002	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-VSL-00007 Instrumentation.
24590-HLW-M6-RLD-00001003	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BRKPT-00007/-00009.
24590-HLW-M6-RLD-00001004	P&ID - HLW Radioactive Liquid Waste Disposal System HCP-RK-00006 Lines For RLD-VSL-00007.
24590-HLW-M6-RLD-00001005	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00032 Wash Lines.
24590-HLW-M6-RLD-00001006	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00032 Wash Lines.
24590-HLW-M6-RLD-00002001	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-VSL-00008 Process Lines.
24590-HLW-M6-RLD-00002002	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-VSL-00008 Process Lines.
24590-HLW-M6-RLD-00002003	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-VSL-00008 Instrumentation.
24590-HLW-M6-RLD-00002004	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BRKPT-00004.
24590-HLW-M6-RLD-00002005	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00042 Wash Lines.
24590-HLW-M6-RLD-00002006	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00032 Wash Lines.
24590-HLW-M6-RLD-00003001	P&ID - HLW Radioactive Liquid Waste Disposal System HSH-SUMP-00002
24590-HLW-M6-RLD-00003002	P&ID - HLW Radioactive Liquid Waste Disposal System HMP-SUMP-00001 HSH-SUMP-00001

Document Number	Title
24590-HLW-M6-RLD-00003003	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00034/HOP-RK-00047 Lines for Sumps.
24590-HLW-M6-RLD-00004001	P&ID - HLW Radioactive Liquid Waste Disposal System HPH-SUMP-00002 and HPH-SUMP-00005.
24590-HLW-M6-RLD-00004002	P&ID - HLW Radioactive Liquid Waste Disposal System HRH-SUMP-00001 and HDH-SUMP-00003.
24590-HLW-M6-RLD-00004003	P&ID - HLW Radioactive Liquid Waste Disposal System HDH-RK-00009 and PWK-RK-00035 Lines for Sumps and Header.
24590-HLW-M6-RLD-00005001	P&ID - HLW Radioactive Liquid Waste Disposal System Miscellaneous Sumps.
24590-HLW-M6-RLD-00005002	P&ID - HLW Radioactive Liquid Waste Disposal System RWH-SUMP-00003/-00004/-00007/-00008.
24590-HLW-M6-RLD-00006	P&ID - HLW Radioactive Liquid Waste Disposal System Fluidics Air Rack RLD-RK-00023.
24590-HLW-M6-RLD-00007	P&ID – HLW Radioactive Liquid Waste Disposal System Fluidics Air Rack RLD-RK-00024.
24590-HLW-M6-RLD-00008001	P&ID - HLW Radioactive Liquid Waste Disposal System HEH-SUMP-00001 and HDH-SUMP-00004.
24590-HLW-M6-RLD-00008002	P&ID - HLW Radioactive Liquid Waste Disposal System HFP-SUMP-00002 and HSH-SUMP-00003.
24590-HLW-M6-RLD-00009	P&ID - HLW Radioactive Liquid Waste Disposal System Steam Rack RLD-RK-00042.
24590-HLW-M6-RLD-00014	P&ID - HLW Radioactive Liquid Waste Disposal System Offgas Drains Collection Vessel.
24590-HLW-M6-RLD-00015001	P&ID - HLW Radioactive Liquid Waste Disposal System HCP-SUMP-00001
24590-HLW-M6-RLD-00015002	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-RK-00042 & PWD-RK-00032.
24590-HLW-M6-RLD-00015003	P&ID - HLW Radioactive Liquid Waste Disposal System HCP-RK-00006 & HOP-RK-00047.
24590-HLW-M6-RLD-00016001	P&ID - HLW Radioactive Liquid Waste Disposal System HDH-SUMP-00001/-00002 and HPH-SUMP-00001/-00003.
24590-HLW-M6-RLD-00016002	P&ID - HLW Radioactive Liquid Waste Disposal System PWD-RK-00035/HDH-RK-00009 Lines for Sumps.
24590-HLW-M6-RLD-00017001	P&ID - HLW Radioactive Liquid Waste Disposal System RWH-SUMP-00001/-00005/-00006.
24590-HLW-M6-RLD-00017002	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-RK-00042 Lines for Sumps.
24590-HLW-M6-RLD-00018001	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BULGE-00008 and RLD-PMP-00018.
24590-HLW-M6-RLD-00018002	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BULGE-00008.
24590-HLW-M6-RLD-00018003	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BULGE-00009 and RLD-PMP-00019.
24590-HLW-M6-RLD-00018004	P&ID - HLW Radioactive Liquid Waste Disposal System RLD-BULGE-00009.

Document Number	Title
24590-HLW-M6-RLD-00018005	P&ID - HLW Radioactive Liquid Waste Disposal System Discharge Lines.
24590-HLW-M6-RLD-20003001	P&ID - HLW Radioactive Liquid Waste Disposal System HSH-SUMP-00005/-00009.
24590-HLW-M6-RLD-20003002	P&ID - HLW Radioactive Liquid Waste Disposal System HSH-SUMP-00006 HMH-SUMp-00003 and -00004.
24590-HLW-M6-RLD-20003003	P&ID - HLW Radioactive Liquid Waste Disposal System HFP-RK-00002 Lines for Sumps.
24590-HLW-M6-RLD-20004001	P&ID - HLW Radioactive Liquid Waste Disposal System HPH-SUMP-00004 and HOP-SUMP-00008.
24590-HLW-M6-RLD-20004002	P&ID - HLW Radioactive Liquid Waste Disposal System HFP-RK-00002 Lines for Sumps.
24590-HLW-M6-RLD-20005001	P&ID - HLW Radioactive Liquid Waste Disposal System Melter 2 Sumps HFP-SUMP-00005 & HSH-SUMP-00007.
24590-HLW-M6-RLD-20005002	P&ID - HLW Radioactive Liquid Waste Disposal System HFP-RK-00002 Lines for Sumps.
General Arrangement Drawings	
24590-HLW-P1-P01T-00001	HLW Vitrification Building General Arrangement Plan at Elevation -21'0"
24590-HLW-P1-P01T-00008	HLW Vitrification Building General Arrangement Sections A-A B-B & C-C
24590-HLW-P1-P23T-00009	HLW Vitrification Building Equipment Location Plan El. -21'0" / Area 9
Data Sheets	
24590-HLW-MVD-RLD-00005	Mechanical Systems Data Sheet: Acidic Waste Vessel
24590-HLW-MVD-RLD-00007	Mechanical Systems Data Sheet: Plant Wash and Drains Vessel
24590-HLW-MVD-RLD-00008	Mechanical Systems Data Sheet: Offgas Drains Collection Tank

Appendix A - Test Objectives, Conditions and Acceptance Criteria

[NOTE]: Demonstrations and tests identified in this appendix are preliminary, pending completion of design activities. They are established to document the flowdown of verification needs established in Section 3 but are not sufficiently detailed for development of specific system and equipment test plans. They may be used for general planning only. This note is to be removed when design is sufficiently progressed to provide the details needed to establish the basis for testing and acceptance criteria.

Requirement (para #)	Plan (including SSCs)*	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.4.1.1.2	Verify capability to determine volume balance during transfers to vessels RLD-VSL-00007/8. Level Detection – CTNs: LT-3240, LT-3241, LT-3152, LT-3153	(GTC) For each incoming transfer to RLD-VSL-00007/8 volume balance is determined.		TBD
3.4.4.4	Verify remotability in accordance with 24590-WTP-PL-RACT-RT-0001, *WTP Remotability Verification Plan.*	(GTC) Successful remote removal and re-installation of the all the RLD equipment/ components listed in the test plans.	Physical demonstration	Commissioning Remotability Program
3.4.4.5	Verify remote valve operation to ensure system operation is as designed.	(GTC) Valves are remotely operable.		TBD
3.4.4.5.1	Verify that power-operated valves closes at or below TBD in/s.	(GTC) Upon actuation, valve actuator is equal or less than TBD in/s.		TBD
3.5.3.1.1, 3.5.3.1.2, 3.5.3.1.3, 3.5.3.2, 3.5.3.5, 3.5.3.6, 3.5.3.8.1, 3.5.3.8.2, 3.5.3.10, 3.5.3.11, 3.5.3.12	Verify that the HLW-RLD system is capable of receiving flows as designed.	(GTC) All inflows connections to the RLD vessels (RLD-VSL-00002/7/8) convey flow to the applicable HLW-RLD vessel(s). Once the transfer device is turned on a level change in the RLD vessel (RLD-VSL-00007/8) is observed via the level instrumentation of the RLD vessel.		Simulant required
3.5.3.7.1	Install design elements required to establish flow from HFP-VSL-00001, HFP-VSL-00005 and the melter feed vessels (HFP-VSL-00002 and HFP-VSL-00006) during decontamination and decommissioning activities and verify flow can be established. **Following successful demonstration, reconfigure to prevent transfers from the melter feed preparation vessels during normal operation.**	(GTC) (1) Steam ejector steam supply piping can be reconfigured to enable heel flush transfers from the melter feed preparation vessels to RLD-VSL-00008. (2) Flow can be established.		
3.5.3.14, 3.7.3.1	Verify that the HLW-RLD system is capable of receiving and transferring effluents as designed.	(GTC) All transfer connections from the RLD vessels (RLD-VSL-00002/7/8) and HLW Facility sumps function as designed.		TBD
3.5.3.15	Verify the sampling function of the HLW-RLD via the ASX system. Sampler – CTN: ASX-SAMPLR-00028 Vessel – CTNs: RLD-VSL-00007, RLD-VSL-00008	(GTC) HLW-RLD delivers sampling flow to ASX-SAMPLR-00028 and returns flow to RLD-VSL-00007 and RLD-VSL-00008.		TBD

Requirement (para #)	Plan (including SSCs)*	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.6.3.1	Verify the capability to flush the following HLW-RLD lines: • RLD line from RLD-VSL-00007 to ASX-SMPLR-00028 • RLD line from RLD-VSL-00008 to ASX-SMPLR-00028 • RLD line from ASX-SMPLR-00028 to RLD-VSL-00007 • RLD line from ASX-SMPLR-00028 to RLD-VSL-00008 line flush from RLD-PMP-00018 to PWD-VSL-00043 • RLD line from RLD-PMP-00019 to PWD-VSL-00043 • RLD line form RLD-PMP-00018 to PWD-VSL-00033 • RLD line from RLD-PMP-00019 to PWD-VSL-00033 • RLD line from RLD-PMP-00018 to RLD-VSL-00007 • RLD line from RLD-PMP-00019 to RLD-VSL-00007 • RLD line from RLD-PMP-00018 to RLD-VSL-00008 • RLD line from RLD-PMP-00019 to RLD-VSL-00008 Perform a baseline flush test measurement without simulant, and then perform a second flush test after a simulant transfer. Sample/Transfer Pumps – CTNs: RLD-PMP-00018, -00019 Vessels – CTNs: RLD-VSL-00007, -00008, PWD-VSL-00033, -00043 Sampler – CTNs: ASX-SMPLR-00028	(GTC) System demonstrates the capability to flush the PT Facility HLW concentrate transfer lines using water from the HLW Facility.		Simulant required
3.7.1.1	Verify that the RLD sump pumps/ejectors are capable of emptying the sumps within 24 hours as required by the WAC. Diaphragm Pumps – CTNs: RLD-PMP-00013, -00023, -00165, -00166, -00188, -00189 Steam Ejectors – CTNs: RLD-EJCTR-00014, -00026, -00027, -00029, -00030, -00049A, -00049B, -00051, -00052A, -00052B, -00053A, -00053B, -00054, -00055, -00061, -00171, -00172, -00173, -00174, -00175, -00176A, -00176B, -00178, -00179	(TAC) System demonstrates the capability to empty sumps with 24 hours as required by the WAC.		TBD
3.7.4.2	Verify the capability to use air to purge steam lines for the RLD steam ejectors. Steam Ejectors – CTNs: RLD-EJCTR-00014, -00026, -00027, -00029, -00030, -00049A, -00049B, -00051, -00052A, -00052B, -00053A, -00053B, -00054, -00055, -00061, -00163, -00171, -00172, -00173, -00174, -00175, -00176A, -00176B, -00178, -00179	(GTC) The RLD steam ejectors steam lines are purged using air after use.		TBD
3.8.3.1	Verify the capability to flush the PJM lines. PJMs – CTNs: RLD-PJM-00001, -00002, -00003, -00004, -00005, -00006, -00007, -00008	(GTC) System demonstrates the capability to deliver the flushing water to the PJMs at the rate and pressure specified per analysis.		TBD
3.8.3.2	Verify the required compressed air is delivered to the PJM at the rate specified per analysis. PJMs – CTNs: RLD-PJM-00001, -00002, -00003, -00004, -00005, -00006, -00007, -00008	(GTC) System demonstrates the capability to deliver the required compressed air to the PJMs at the rate specified per analysis.		TBD
3.9.1.1.1	Verify the capability to remotely monitor the HLW-RLD vessels (RLD-VSL-00002, -00007, -00008) temperature, pressure, and effluent level. Temperature Elements - CTNs: TE-3025, TE-3214, TE-3115 Pressure Indicators – CTNs: PT-3216, PT-3026, PT-3151 Level Detection – CTNs: LT-3240, LT-3241, LT-3024, LT-3152, LT-3153	(GTC) Temperature, pressure, and level elements are monitored and displayed on the PCJ.		PCJ operating and monitoring simulate RLD vessels temperature, pressure, level.

Requirement (para #)	Plan (including SSCs)*	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.9.1.2.1	Verify the capability to remotely monitor liquid in all the sumps that discharges to the HLW-RLD vessels (RLD-VSL-00007/8). Sumps – CTNs: HCP-SUMP-00001, HOP-SUMP-00002, HOP-SUMP-00003, RLD-SUMP-00001, HDH-SUMP-00001, HDH-SUMP-00002, HDH-SUMP-00003, HDH-SUMP-00004, HPH-SUMP-00001, HPH-SUMP-00002, HPH-SUMP-00003, HPH-SUMP-00004, HPH-SUMP-0005, HRH-SUMP-00001, HEH-SUMP-00001, HFH-SUMP-00001, HOP-SUMP-00008, HMH-SUMP-00001, HMH-SUMP-00002, HMH-SUMP-00003, HMH-SUMP-00004, HSH-SUMP-00001, HSH-SUMP-00002, HSH-SUMP-00003, HSH-SUMP-00005, HSH-SUMP-00006, HSH-SUMP-00007, HSH-SUMP-00008, HSH-SUMP-00009, HFP-SUMP-00002, HFP-SUMP-00005, RWH-SUMP-00001, RWH-SUMP-00002, RWH-SUMP-00003, RWH-SUMP-00004, RWH-SUMP-00005, RWH-SUMP-00006, RWH-SUMP-00008	(GTC) The presence of liquid in sumps that discharge to the RLD vessels (RLD-VSL-00007/8) are monitored and displayed on the PCJ.		TBD
3.9.1.2.2	Verify that upon receiving a high-high liquid level signal from sumps listed below, valves supplying PWD to the sumps close and an alarm is annunciated. Sumps – CTNs: HSH-SUMP-00002, HFP-SUMP-00002, HSH-SUMP-00003, HOP-SUMP-00003, HCP-SUMP-00001, HSH-SUMP-00005, HOP-SUMP-00008, HSH-SUMP-00007, HFP-SUMP-00005 Valves – CTNs: PWD-YV-0021, PWD-YV-0026, PWD-0031, PWD-YV-0060, PWD-YV-0077, PWD-YV-0093	(GTC) A high-high liquid level signal from any of sumps listed will close the valve supplying the PWD to the sump.		TBD
3.9.1.2.3	Verify that upon receiving a high liquid level signal from the sumps listed below, (1) an alarm is initiated, and (2) the valves that supply water/effluent directly to the sumps close. Sumps – CTNs: HCP-SUMP-00001, RLD-SUMP-00001 Valves – CTNs: RLD-YV-3247, RLD-YV-3226	(GTC) A high liquid level signal from any of sumps listed closes the valves that supply various sources of water/effluent to the sump.		TBD
3.9.1.2.4	Verify that, upon receiving a low liquid level signal from the sumps listed below, valves used to facilitate effluent transfer close. Sumps – CTNs: HCP-SUMP-00001, HOP-SUMP-00002, HOP-SUMP-00003, RLD-SUMP-00001, HDH-SUMP-00001, HDH-SUMP-00002, HDH-SUMP-00003, HDH-SUMP-00004, HPH-SUMP-00001, HPH-SUMP-00002, HPH-SUMP-00003, HPH-SUMP-00004, HPH-SUMP-0005, HRH-SUMP-00001, HEH-SUMP-00001, HFH-SUMP-00001, HOP-SUMP-00008, HMH-SUMP-00001, HMH-SUMP-00002, HMH-SUMP-00003, HMH-SUMP-00004, HSH-SUMP-00001, HSH-SUMP-00002, HSH-SUMP-00003, HSH-SUMP-00005, HSH-SUMP-00006, HSH-SUMP-00007, HSH-SUMP-00008, HSH-SUMP-00009, HFP-SUMP-00002, HFP-SUMP-00005, RWH-SUMP-00001, RWH-SUMP-00002, RWH-SUMP-00003, RWH-SUMP-00004, RWH-SUMP-00005, RWH-SUMP-00006, RWH-SUMP-00008 Valves – CTNs: RLD-YV-3233, RLD-YV-3511, RLD-YV-3502, RLD-YV-3235, RLD-YV-3234, RLD-YV-3429, RLD-YV-3432, RLD-YV-3427, RLD-YV-3425, RLD-YV-3815, RLD-YV-3426, RLD-YV-3431, RLD-YV- RLD-YV-3428, RLD- YV-3430, RLD-YV-3818, RLD-YV-3505, RLD-YV-3551, RLD-YV-3552, RLD-YV-3318, RLD-YV-3319, RLD-YV- 3368, RLD-YV-3369, RLD-YV-3320, RLD-YV-3320, RLD-YV-3317, RLD-YV-3806, RLD-YV-3367, RLD-YV-3370, RLD-YV-3856, RLD-YV-3316, RLD-YV-3366, RLD-YV-3821, RLD-YV-3871, RLD-YV-3525, RLD-YV-3508, RLD-YV-RLD-RLD-YV-3808, RLD-YV-3518, RLD-YV-3811, RLD-YV-3814, RLD-YV-3522	(GTC) A low liquid level signal from the sumps discharging to the RLD vessels (RLD-VSL-00007/8) closes the valves used to facilitate transfer from sumps to the RLD vessels.		TBD
3.9.1.3.1	Verify the capability to remotely monitor effluent temperature within the RLD manifolds. Temperature Elements - CTNs: TE-3110, TE-3408, TE-3352, TE-3421, TE-3302	(GTC) Temperature elements are monitored and displayed on the PCJ.		PCJ operating and monitoring simulate RLD manifold temperature.

Requirement (para #)	Plan (including SSCs)*	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.9.1.3.2	Verify that upon receiving a high-high temperature signal from the RLD manifold (1) an alarm is initiated and (2) the sump/vessel's transfer ejector valves that transfer effluents to the RLD manifolds close. Valves – CTNs: HDH-YV-0176, RLD-YV-3425, RLD-YV-3427, RLD-YV-3426, RLD-YV-3429, RLD-YV-3806, RLD-YV-3316, RLD-YV-3317, RLD-YV-3428, RLD-YV-3856, RLD-YV-3552, RLD-YV-3551, RLD-YV-3476, RLD-YV-3366	(GTC) A high-high temperature signal from the RLD manifolds sends a trip to close the sump/vessel's transfer ejector valves that transfer to the RLD manifolds.		TBD
3.9.1.3.3	Verify the capability to remotely monitor liquid level within the HLW-RLD overflow seal loops.	(GTC) The levels in HLW-RLD seal loops are monitored and displayed on the PCJ.		TBD
3.9.1.1.2	Verify that, upon receiving a high liquid level signal at the required setpoint (TBD) from vessel RLD-VSL-00008, the valves that supply the motive fluid to the diaphragm pumps or steam ejectors cannot open. Valves – CTNs: RLD-YV-3317, RLD-YV-3316, RLD-YV-3318, RLD-YV-3425, RLD-YV-3428, RLD-YV-3021, RLD-YV-3022, RLD-YV-3233, RLD-YV-3366, RLD-YV-3367, HFP-YV-0033, HFP-YV-0049, HFP-YV-2033, HFP-YV-2049	(GTC) A high liquid level signal from vessel RLD-VSL-00008 prevents the initiation of sumps discharge to vessel RLD-VSL-00008.		TBD
3.9.1.1.3	Verify that, upon receiving a high-high liquid level signal from vessel RLD-VSL-00008 (as appropriate) at the required setpoint (TBD), the valves on piping discharging into vessel RLD-VSL-00008, and the valves providing motive power to the diaphragm pumps or steam ejectors discharging to the vessel RLD-VSL-00008 close. Valves – CTNs: RLD-YV-3142, RLD-YV-3147, RLD-YV-3148, RLD-YV-3222, RLD-YV-3223, RLD-YV-3244, RLD-YV-3229, RLD-YV-3301, RLD-YV-3318, RLD-YV-3319, RLD-YV-3320, RLD-YV-3317, RLD-YV-3316, RLD-YV-3431, RLD-YV-3430, RLD-YV-3407, RLD-YV-3425, RLD-YV-3428, RLD-YV-3518, RLD-YV-3522, RLD-YV-3525, RLD-YV-3505, RLD-YV-3508, RLD-YV-3511, RLD-YV-3815, RLD-YV-3818, RLD-YV-3821, RLD-YV-3806, RLD-YV-3021, RLD-YV-3022, RLD-YV-3501, RLD-YV-3502, RLD-YV-3233, RLD-YV-3235, RLD-YV-3234, RLD-YV-3420, RLD-YV-3429, RLD-YV-3432, RLD-YV-3426, RLD-YV-3427, RLD-YV-3808, RLD-YV-3811, RLD-YV-3814, RLD-YV-3366, RLD-YV-3367, RLD-YV-3351, RLD-YV-3368, RLD-YV-3369, RLD-YV-3370, RLD-YV-3476, RLD-YV-3552, RLD-YV-3551, RLD-YV-3871, RLD-YV-3856, HFP-YV-0033, HFP-YV-0049, HFP-YV-2033, HFP-YV-2049, PWD-YV-0026, PWD-YV-0031, PWD-YV-0039, PWD-YV-0021, PWD-YV-0087, PWD-YV-0077, PWD-YV-0093, PWD-YV-0060, HSH-PMP-00001, HSH-PMP-00002, HDH-YV-0176	(GTC) A high-high liquid level signal from vessel RLD-VSL-00008 closes (1) the valves on piping discharging into vessel RLD-VSL-00008 and (2) valves providing motive power to the diaphragm pumps or steam ejectors discharging to the vessel RLD-VSL-00008.		TBD
3.9.1.1.2	Verify that, upon receiving a high liquid level signal at the required setpoint (TBD) from vessel RLD-VSL-00007, the valves that supply the motive fluid to the diaphragm pumps or steam ejectors cannot open. Valves – CTNs: RLD-YV-3232, RLD-YV-3501, RLD-YV-3502	(GTC) A high liquid level signal from vessel RLD-VSL-00007 prevents the initiation of sumps discharge to vessel RLD-VSL-00007.		TBD
3.9.1.1.2	Verify that, upon receiving a high liquid level signal at the required setpoint (TBD) from vessel RLD-VSL-00007, the valves that supply the motive fluid to the diaphragm pumps or steam ejectors cannot open. Pumps – CTNs: RLD-PMP-00018, RLD-PMP-00019, HSH-PMP-00001, HSH-PMP-00002.	(GTC) A high liquid level signal from vessel RLD-VSL-00007 prevents the initiation of sumps discharge to vessel RLD-VSL-00007.		TBD

Requirement (para #)	Plan (including SSCs)*	Acceptance Criteria (TAC or GTC)*	Notes/Comments	Test Conditions
3.9.1.1.3	Verify that, upon receiving a high-high liquid level signal from vessel RLD-VSL-00007 at the required setpoint (TBD), the valves on piping discharging into vessel RLD-VSL-00007, and the valves providing motive power to the diaphragm pumps or steam ejectors discharging to the vessel RLD-VSL-00007 close. Valves – CTNs: RLD-YV-3105, RLD-YV-3156, RLD-YV-3232, RLD-YV-3140, RLD-YV-3141, RLD-YV-3501, RLD-YV-3502, RLD-YV-3237, HDH-YV-0174, HDH-YV-0175, HOP-YV-0121, HOP-YV-0128, HOP-YV-2121, PWD-YC-0026, HOP-YC-2120	(GTC) A high-high liquid level signal from vessel RLD-VSL-00007 closes (1) the valves on piping discharging into the vessel RLD-VSL-0007, and (2) valves providing motive power to the diaphragm pumps or steam ejectors discharging to the vessel RLD-VSL-00007.		TBD
3.9.1.1.4	Verify that a low-low liquid level from the vessel RLD-VSL-00007 or vessel RLD-VSL-00008 at the required setpoint(s) (TBD) stops the RLD sample/transfer pumps (RLD-PMP-00018/19). Pumps – CTNs: RLD-PMP-00018, RLD-PMP-00019 Level indicators – CTNs: TBD	(GTC) A low-low liquid level signal from the vessel RLD-VSL-00007 or vessel RLD-VSL-00008 stops the RLD sample/transfer pumps (RLD-PMP-00018/19).		TBD
3.9.1.1.5	Verify that a low-low liquid level signal at the required setpoint (TBD) from RLD-VSL-00002 closes ejectors valves used to facilitate transfer of effluents from RLD-VSL-00002. Ejectors – CTNs: RLD-EJCTR-00020A, RLD-EJCTR-00020B Level indicators – CTNs: RLD-LI-3024A	(GTC) A low-low liquid level signal from RLD-VSL-00002 closes ejectors valves used to facilitate transfer of effluents from RLD-VSL-00002.		TBD
3.9.2.1	Verify leak detection capability for sumps (discharging to the RLD Vessels) as described in the WTP Dangerous Waste Permit. Sumps – CTNs: RLD-SUMP-00001, HCP-SUMP-00001, HDH-SUMP-00001, HDH-SUMP-00002, HDH-SUMP-00003, HFP-SUMP-00002, HFP-SUMP-00005, HOP-SUMP-00003, HOP-SUMP-00008, HPH-SUMP-00001, HPH-SUMP-00003, HPH-SUMP-00005, HSH-SUMP-00003, HSH-SUMP-00007, HSH-SUMP-00008, HSH-SUMP-00009.	(GTC) The leaks in the sumps listed are monitored and an alarm is given when a leak in sump is detected.	The minimum detectable level for each sump is required to establish the demonstration acceptance criteria for each sump. This level remains as TBD until radar gun vendor information is available.	TBD
3.9.2.2	Verify that a high liquid level signal from the autosampler (ASX-SAMPLR-00028) level instrumentation via PPJ stops the HWLR-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019). Pumps – CTNs: RLD-PMP-00018, RLD-PMP-00019 Autosampler – CTNs: ASX-SMPLR-00028 Level Instruments – CTNs: TBD	(TAC) A high level signal from the ASX enclosure for ASX-SMPLR-00028 stops RLD sample/transfer pumps.		TBD
3.9.2.3	Verify that the HWLR-RLD sample/transfer pumps (RLD-PMP-00018 and RLD-PMP-00019) are prevented from running via signal from PPJ when valve associated with the autosampler (ASX-SAMPLR-00028) flushing are aligned for flushing. Pumps – CTNs: RLD-PMP-00018, RLD-PMP-00019 Valves – CTNs: TBD	(TAC) When valves (TBD) are in the flushing alignment (i.e., open/closed) RLD-PMP-00018 and RLD-PMP-00019 operation cannot be initiated or stop (if currently operating).		TBD

Notes:
* Test acceptance criteria (TAC) are based on requirements from authorization basis documents. General test criteria (GTC) are requirements from other sources.

Appendix B- Description of System Functional Flow and Interactions

Function: A.1.1	Receive Process Effluents
Detail description: All radioactive process effluents routinely generated during production of HLW glass are processed through the RLD system. RLD-VSL-00007 and RLD-VS-00008 are redundant for receiving routine process effluent transfers (inputs).	
Initiation: This function initiates when a source of primary effluent is ready to transfer, and a receiving vessel is available.	
Termination: This function terminates when the receiving vessel is at high operating volume.	
Parallel or sequential functions: PJM operation (optional)	
Applicable Modes: Routine and non-routine operations	

Function: A.1.2	Collect and Transfer Offgas Condensate
Detail description: Process condensate is continuously collected in RLD-VSL-00002, and is batch transferred to RLD-VSL-00007 or RLD-VS-00008. The operator determines when to transfer based on level of effluent in RLD-VSL-00002 and availability of RLD-VSL-00007 or RLD-VS-00008.	
Initiation: This transfer function is initiated by the operator.	
Termination: This function terminates when the sending vessel is at the low operating volume or receiving vessel is at high operating volume.	
Parallel or sequential functions: All	
Applicable Modes: Routine and non-routine operations	

Function: A.1.3	Transfer Sump Liquids
Detail description: Sump liquids (only applicable to sumps that can receive high solids), miscellaneous recycles, and drains are transferred to RLD-VSL-00007 or RLD-VSL-00008. The operator determines when to transfer based on the availability of RLD-VSL-00007/8.	
Initiation: This function initiates when a non-routine source is ready to transfer and the receiving vessel is available. Sump liquid transfers are initiated by the operator per a recovery plan.	
Termination: This function terminates when the sending source is at the low operating volume or receiving vessel is at high operating volume.	
Parallel or sequential functions: PJM operation (optional)	
Applicable Modes: Routine and non-routine operations	

Function: A.1.4	Receive miscellaneous liquids
Detail description: RLD vessel RLD-VSL-00008 receives effluents from PCW blow-down or suspect radioactively contaminated plant cooling water purge, off-spec NLD chemical effluent, heel flush transfers from the HFP vessels, liquids from the decontamination glove box or booth and drains from the PWD racks.	
Initiation: This transfer function is initiated by the operator.	
Termination: This transfer function is initiated by the operator.	
Parallel or sequential functions: PJM operation (optional)	
Applicable Modes: Routine and non-routine operations	

Function: A.2	Store Effluents
Detail description: Effluents received in RLD-VSL-00007 and RLD-VSL-00008 are temporarily stored until the inventory is sufficient to warrant conditioning and transfer to the Pretreatment Facility.	
Initiation: This function initiates when effluent receipt is complete.	
Termination: This function terminates when conditioning and/or transfer begins	
Parallel or sequential functions: PJM (optional)	
Applicable Modes: All	

Function: A.3	Mix Vessel Inventory
Detail description: Mixing of the vessel inventory is performed to suspend insoluble solids and to blend liquids.	
Initiation: This function initiates prior to sampling, neutralization, quenching, and transfer.	
Termination: This function terminates at the end of transfer to the PT Facility or at low operating level.	
Parallel or sequential functions: Transfer Vessel Inventory, Sample Vessel Inventory, Condition Vessel Inventory, and Vessel Flushing	
Applicable Modes: Routine and non-routine operations	

Function: A.4	Sample Vessel Inventory
Detail description: The RLD vessel inventory is circulated through an auto sampler, which extracts a sample to the ASX for analysis in the Analytical Laboratory. Sampling of each batch is not required and is not a process "hold" point for analytical results.	
Initiation: This function initiates when directed by the operations supervisor.	
Termination: This function terminates when sampling is complete.	
Parallel or sequential functions: Mix Vessel Inventory	
Applicable Modes: Routine operations	

Function: A.5	Condition Vessel Inventory
Detail description: The vessel inventory is treated as required to meet process conditions. Sample data or process knowledge is used to determine the quantity of sodium hydroxide reagent to add to neutralize the inventory and to increase the solution pH. Demineralized water is added through the PWD rack to quench the vessel inventory if the temperature is too high for pump operation.	
Initiation: This function initiates prior to transfer from RLD-VSL-00007 or RLD-VSL-00008.	
Termination: This function terminates when all conditioning has been completed.	
Parallel or sequential functions: Mix vessel inventory	
Applicable Modes: Routine and non-routine operations	

Function: A.6	Transfer Vessel Inventory
Detail description: Conditioned effluent is batch transferred from RLD-VSL-00007 and RLD-VSL-00008to the PT Facility for processing.	
Initiation: This function initiates when conditioning is complete and a permissive signal is received from the PT Facility.	
Termination: This function terminates when the RLD vessel is at low operating level, or the receiving vessel is full (PT Facility transfer permissive is removed).	
Parallel or sequential functions: Mix Vessel Inventory	
Applicable Modes: Routine operations	

Function: B.1.1	Flush Sample and Transfer Lines
Detail description: DIW and NAR flush volume are supplied as needed from the PWD rack to flush sample and transfer lines following each use to remove solids from the lines.	
Initiation: This function initiates after pumps stop.	
Termination: This function terminates by flow totalizer indication.	
Parallel or sequential functions: Mix Vessel Inventory	
Applicable Modes: Routine operations	

Function: B.1.2	Flush RLD Vessels
Detail description: RLD-VSL-00007 and RLD-VSL-00008 are flushed with DIW as necessary to remove heel liquid and solids. DIW and NAR flush volume are supplied from the PWD rack.	
Initiation: This function initiates when directed by operations supervisor for heel cleanout.	
Termination: This function terminates by vessel volume indication.	
Parallel or sequential functions: Mix Vessel Inventory	
Applicable Modes: Non-routine operations	

Function: B.1.3	Flush and Wash System Components
Detail description: Flush and wash system components as required to keep radiation exposure ALARA for maintenance. Flush water is supplied from the PWD Racks.	
Initiation: This function initiates when directed by operations supervisor to minimize radiation buildup.	
Termination: This function terminates when directed by operations supervisor.	
Parallel or sequential functions: Mix Vessel Inventory	
Applicable Modes: Non-routine operations	

Function: C.1.1	Vent Vessel Headspace
Detail description: Vent RLD-VSL-00007 and RLD-VSL-00008 headspaces to the PVV. RLD-VSL-00002 headspace to the C5 ventilation via the overflow.	
Initiation: This function is continuous	
Termination: NA	
Parallel or sequential functions: All	
Applicable Modes: All	

Function: C.1.2	Vent Process Line High Points
Detail description: Vent process line high points to the PVV for hydrogen mitigation.	
Initiation: High point line vents open to PVV when pumps are off.	
Termination: High point line vents close prior to pump start	
Parallel or sequential functions: Mix Vessel Inventory, Store Vessel Inventory, and Condition Vessel Inventory	
Applicable Modes: Routine operations	

Function: C.1.3	Maintain Vessel Headspace
Detail description: Maintain vessel headspace by providing an overflow path. RLD-VSL-00002 over-flows to RLD-SUMP-00001. RLD-VSL-00007 and RLD-VSL-00008 overflow to the HCP-SUMP-00001via a seal loop to maintain vessel pressure in a limited operating range.	
Initiation: This function is continuous	
Termination: NA	
Parallel or sequential functions: All	
Applicable Modes: All	

Function: D.1	PCJ – Non-Safety Monitoring, Control, and Communication
Detail description: PCJ provides non-safety monitoring and control functions. Components that are controlled automatically by the PPJ are also monitored by the PCJ during normal operations. The functions that are monitored and controlled by the PCJ are: • Monitor the temperature, pressure, and level of the RLD vessels contents • Monitor the liquid level in the sumps discharging to the RLD vessels • Detect and indicate liquid level in the RAD area sumps and detect leaks in the sumps • Monitor RLD seal loops liquid level • Process control through trips and interlocks via monitoring internal conditions in vessels, sumps, and associated piping. Components such as pumps and valves are also remotely operated	
Initiation: This function initiates when the HLW Facility is in startup operations.	
Continuous: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: All	
Termination: NA	
Parallel or sequential functions: All	
Applicable Modes: All	

Function: E.1	Utilize Electrical Power
Detail description: Electrical power to the HLW-RLD equipment and instruments is supplied by the LVE system. Initiation: This function initiates when the HLW Facility is in startup operations.	
Continuous: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: All	
Termination: NA	
Parallel or sequential functions: All	
Applicable Modes: All	

Function: E.2	Utilize non-safety compressed air
Detail description: Instrument air from the ISA system is used to provide motive power for remotely actuated valves, bubbler instrumentation, and purge air for the RLD-VSL-00007 and RLD-VSL-00008 overflow line..	
Continuous: This function terminates when HLW glass production operations are complete.	
Parallel or sequential functions: All	

Applicable Modes: All
Termination: NA
Parallel or sequential functions: All
Applicable Modes: All

Appendix C- Active Safety Instruments and Functions

The following safety functions and components are required to implement the safety interlocks via PPJ. The components (sensors and final elements) shall be connected to the PPJ.

No active safety functions are identified.

Appendix D System Procedures

RESERVED

Appendix E System History

RESERVED

Attachment 3
16-ECD-0048
(171 Pages Excluding Cover Sheet)

LAW Primary Offgas (LOP) and Secondary Offgas/Vessel Vent (LVP) System Design Description

24590-LAW-3ZD-LOP-00001

Issued by
RPP-WTP PDC

LAW Primary Offgas (LOP) and Secondary Offgas/Vessel Vent (LVP) System Design Description

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Checked by:	Phil Townsend
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Concurrence:	Jeremy Wilkins for Mark Johnson
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Approved by:	Natalie Harkey
Approver's position:	Systems Engineering Manager
Approver's signature:	Signature — Date: 3/28/2016

Validation

Appl.	Requirement Area	Requirement Developer	Signature	Date
☐	Architectural Design			
☐	Civil/Structural Design			
☑	Controls & Instrumentation Design	WAYNE WINDERHILL		3/15/16
☐	Electrical Design & AHJ			
☑	Fire Protection Engineering	BEN JOHNSON		3/15/16
☑	HVAC Design	J.S. LEAM		03.15.16
☑	Mechanical Handling Design	J.S. LEAM		03.15.16
☑	Mechanical Systems Design	J.S. LEAM		03.15.16
☐	Plant Design			
☐	Process Engineering			
☐	Interface (External)			
☐	Interface (Internal)			
☑	System Functions and Requirements	P.J. Townsend		3/23/16
☐	Equipment Environmental Qualification			
☐	Materials Engineering / Technology			
☐	Plant Software Design			
☑	Environmental Permitting (ESH)	Roger J. Landon		3/18/16
☑	Nuclear Safety Engineering	Robert Birchenough		3/21/2016
☐	Criticality Safety			
☑	Radiological Engineering	RUSSELL LANSER		3/15/16
☐	Industrial Safety/Hygiene (ESH)			
☐	Mission (WTP Contract functional/ performance rqmts)			
☑	Operations Requirements Document (Plant Ops)	Tim Dallas		3/15/16
☑	Quality Assurance	CHUCK ALBIN	(PER EMAIL)	9/10/15
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1 Introduction

1.1 System Identification

This system design description (SDD) defines the technical, functional, and performance requirements of the Low-Activity Waste (LAW) Facility primary offgas process system (LOP) and secondary offgas/vessel vent process system (LVP). This document details waste treatment requirements, environmental compliance requirements, and authorization basis requirements of the LOP and LVP systems as they are currently known and understood. This SDD describes the process and functional design requirements of the LOP and LVP systems, including the following:

- Services and utility requirements, operating materials and supplies, and other external interfaces
- Operations limits and design bases
- Other criteria and requirements pertinent to the design of the LOP and LVP systems

The LOP and LVP systems comprise the LAW offgas system. The offgas system's most important function is to provide the motive force for maintaining the melter plenums at negative pressure by removing generated offgas from the melters and discharging at the stack. Also, the offgas system both cools and heats the offgas where needed to protect the system from exceeding design temperatures, precluding the formation of condensation, and maintaining process temperatures to allow proper offgas treatment. When operating in the PT (baseline) configuration, secondary effluents from the LOP and LVP systems are sent to the PT Facility for further treatment and disposal. When operating in the direct-feed low activity waste (DFLAW) operating configuration, secondary effluents from the LOP and LVP systems are sent to the Effluent Management Facility (EMF) for further treatment and disposition.

1.2 Limitations and Scope

The scope of this document is to provide an authoritative source for the collected set of requirements applicable to the LOP and LVP systems, inclusive of interface requirements with other systems. DFLAW scope and associated applicable design requirements have been incorporated in Sections 1-3 of this document only. Updates to Section 4 will be incorporated at a later date once the detailed design process for DFLAW has been completed. The SDD scope is limited to LOP and LVP system features that support production and/or protect equipment, personnel, and the environment. The SDD is prepared in accordance with 24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions*. The intended use of these collected requirements is to establish the following:

- Inform the LOP and LVP system design effort
- Provide a validated basis upon which to confirm implementation of design requirements
- Provide the expected means of verification for requirements, including those that are post-construction (i.e., startup and commissioning test objectives and acceptance criteria)

All requirements established in this document are intended to be verified to be implemented in design and/or physical configuration using a graded approach commensurate with importance and risk.

Where numeric values are provided within requirements in Section 3, these values are provided without additional margin. For example, if a value is established in 24590-WTP-DB-ENG-01-001, *Basis of Design*, no attempt is made to remove any margin that may or may not have gone into the establishment of that value, and neither has

any margin been added. Where values are stated as minimums or maximums, there is no expectation that additional margin be applied in the verifications that the design requirements have been met. Testing required to be performed in accordance with external codes and standards must follow the rules established in those documents.

This document is intended to be used in support of design development, design verification, turnover, startup testing, and commissioning activities. This document will be maintained current relative to changes in source requirements documents. Updates shall be made concurrent with these changes to source requirements, or implementation shall be tracked for completion in accordance with 24590-WTP-GPG-ENG-0170, *Impact Evaluation*.

Engineers are expected to be able to use the requirements in Section 3 of this document as input for design development without recourse to the upper-tier source documents or searches of the Technical Requirements Management System supported by Technical Requirements Search Application. Design engineers are still required to ensure that requirements contained with the discipline/functional standards incorporated by reference in Section 3 are followed. These documents contain additional criteria that are based on applications of external codes/standards, corporate best practices, and engineering management expectations for a consistent approach to design.

Certain requirement statements in this document are preceded by a "**[HOLD]**" notation. This notation is used when there are unresolved technical issues, known inconsistencies among source requirements, or other management suspensions of work requiring resolution. Requirements with the "**[HOLD]**" notation may be used to proceed with preliminary or committed design (with inclusion of appropriate holds) but shall not be used in support of fabrication or construction until the "**[HOLD]**" is removed.

The contents of Section 4 are being developed in a phased approach in support of future operations and maintenance. At this revision, only the contents of Sections 4.1.1 through 4.1.4 and 4.1.6 have been updated and verified. Sections 4.1.5, 4.2, 4.3, and 4.4 are currently reserved and will be updated in a later phase after the work to support completion of these sections has been completed.

1.3 Ownership and Maintenance

The Design Authority (DA) organization is responsible for the preparation and maintenance of this document through turnover of the included systems to Operations. Thereafter, maintenance of this document is the responsibility of the Plant Engineering organization; however, the Engineering DA organization retains responsibility for the establishment and definition of design requirements.

1.4 Definitions/Glossary

Confinement – For consistency–regardless of usage elsewhere—confinement is used in this document to denote the controls used to prevent or minimize the release or migration of airborne contaminants, including aerosols, hazardous vapors, or gases.

Containment – For consistency—regardless of usage elsewhere—containment is used in this document to denote the controls used to prevent or minimize the release or migration of liquid or liquid-entrained contaminants.

Primary confinement and containment – The structures, systems, or components (SSC) and their associated boundaries that confine or contain airborne and liquid contaminants under normal conditions.

Secondary confinement and containment – The structures or other design features that capture and prevent further spread or migration of airborne or liquid contaminants after they have escaped primary confinement or containment.

1.5 Acronyms and System Designators

1.5.1 Acronyms

AC	alternating current
ACFM	actual cubic feet per minute
ADS	air displacement slurry
AHJ	authority having jurisdiction
ALARA	as low as reasonably achievable
ASME	American Society of Mechanical Engineers
ASD	Adjustable Speed Drive
BACT	Best Available Control Technology
BARCT	Best Available Radionuclide Control Technology
BARD	Bases Assumptions and Requirements Document
BOD	Basis of Design
CDI	configuration data index
CO	carbon monoxide
COM	commissioning
DBE	Design Basis Event
DC	direct current
DCS	distributed control system
DFLAW	Direct Feed Low Activity Waste
DIW	demineralized water
DOE	US Department of Energy
DRE	destruction and removal efficiency
EMF	effluent management facility
EPDM	ethylene propylene diene monomer
HEPA	high-efficiency particulate air
ILAW	immobilized low-activity waste
LAW	Low Activity Waste
LED	light emitting diode
NFPA	National Fire Protection Association
OD	outside diameter
ORD	Operations Requirements Document
P&ID	piping and instrumentation diagram
PDSA	preliminary documented safety analysis
PLC	programmable logic controller
PM	Particulate Matter
PM10	Particulate Matter under 10 microns

PODC	principal organic dangerous constituents
PSUP	power supply
PT	Pretreatment (Facility)
ROIN	requirement object identification number
RTU	remote terminal unit
SBS	submerged bed scrubber
SC-III	seismic category III
SCFM	standard cubic feet per minute
SCO	selective catalytic oxidation unit
SCR	selective catalytic reducer
SDD	system design description
SIR	switch integrated rectifier
SQR	supplier quality representative
SRD	Safety Requirements Document
SS	safety significant
SSC	structures, systems, or components
STEL	short term exposure limits
SUB	subcontractor
TEQ	toxicity equivalence
T/R	transformer/rectifier
UPS	uninterruptible power supply
VOC	volatile organic compound
WESP	wet electrostatic precipitator
WG	water gage
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1.5.2 System Designators

CxV	Cx ventilation system
CHW	chilled water system
DEP	DFLAW effluent management facility process system
DIW	demineralized water system
ISA	instrument service air system
LCP	LAW concentrate receipt process system
LFP	LAW melter feed process system
LMP	LAW melter process system
LOP	LAW primary offgas process system
LVE	low voltage electrical system
LVP	LAW secondary offgas/vessel vent process system
PCJ	process control system
PPJ	programmable protection system
PSA	plant service air system
RLD	radioactive liquid waste disposal system
RWH	radioactive solid waste handling system
SDJ	stack discharge monitoring system
SHR	sodium hydroxide reagent system
UPE	uninterruptible power electrical system

2 General Overview

The Hanford Tank Waste Treatment and Immobilization Plant (WTP) Contract (DE-AC27-01RV14136) and functional specification (Level 1) provides inputs to requirements development (see 24590-WTP-RPT-ENG-01-001, *Technical Baseline Description*). Requirements development documents are communication tools between the Project office and the client (U.S. Department of Energy Office of River Protection) and include the following (Level 2) documentation:

- Authorization basis (safety compliance strategy)
- Flowsheets (throughput compliance strategy)
- Immobilized low-activity waste (ILAW) compliance plans
- Operations Requirements Document (ORD) (24590-WTP-RPT-OP-01-001)
- Permits (environmental compliance strategy)
- External interface control documents

The following context diagrams show inputs and outputs associated with the vessel ventilation header, LOP primary, and LVP secondary systems (see Figure 2-1, and Figure 2-2). This diagram does not differentiate among some utilities that have both normal and safety service provisions. This diagram is used in support of functional and performance definition at the system level. Figure 2-3 provides a simplified process flow diagram of the overall LOP and LVP systems. See Section 1.5 for the list of relevant system designators.

Figure 2-1 LOP System Context Diagram

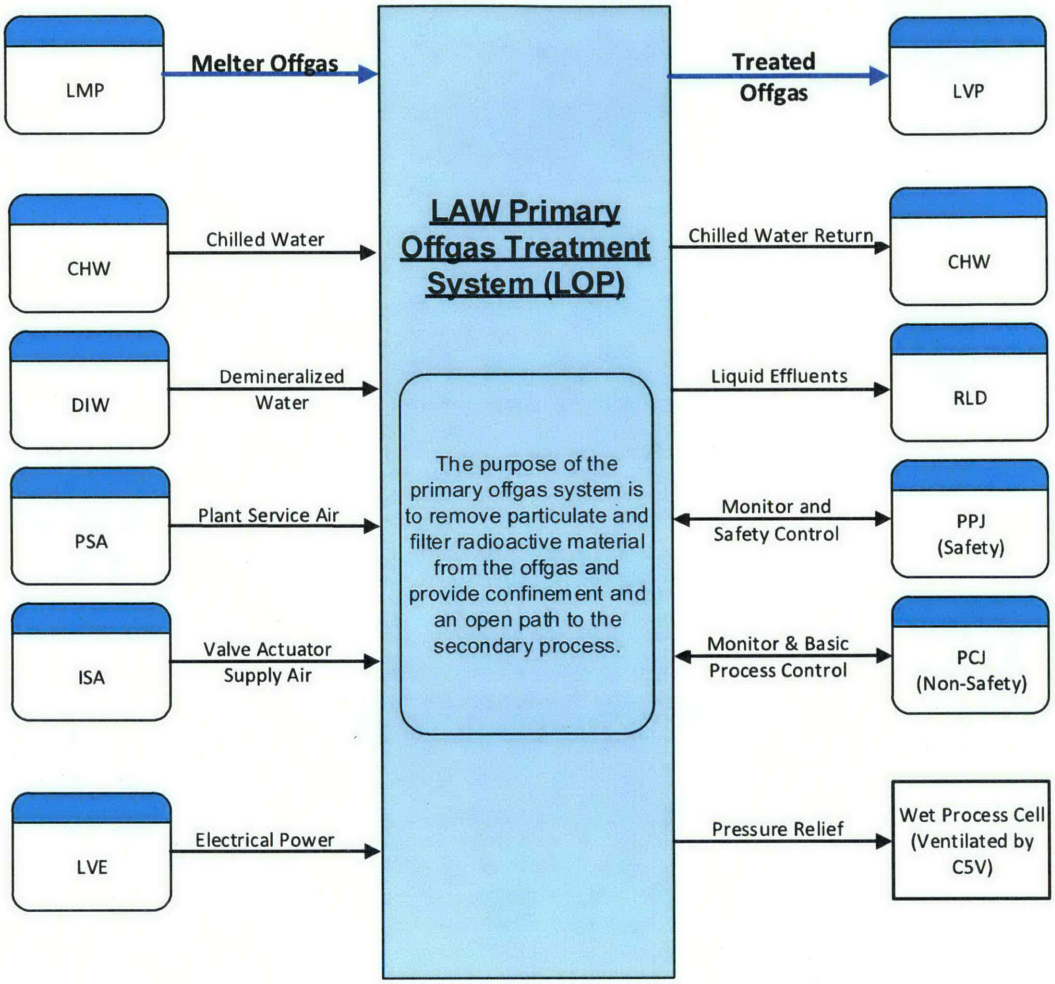
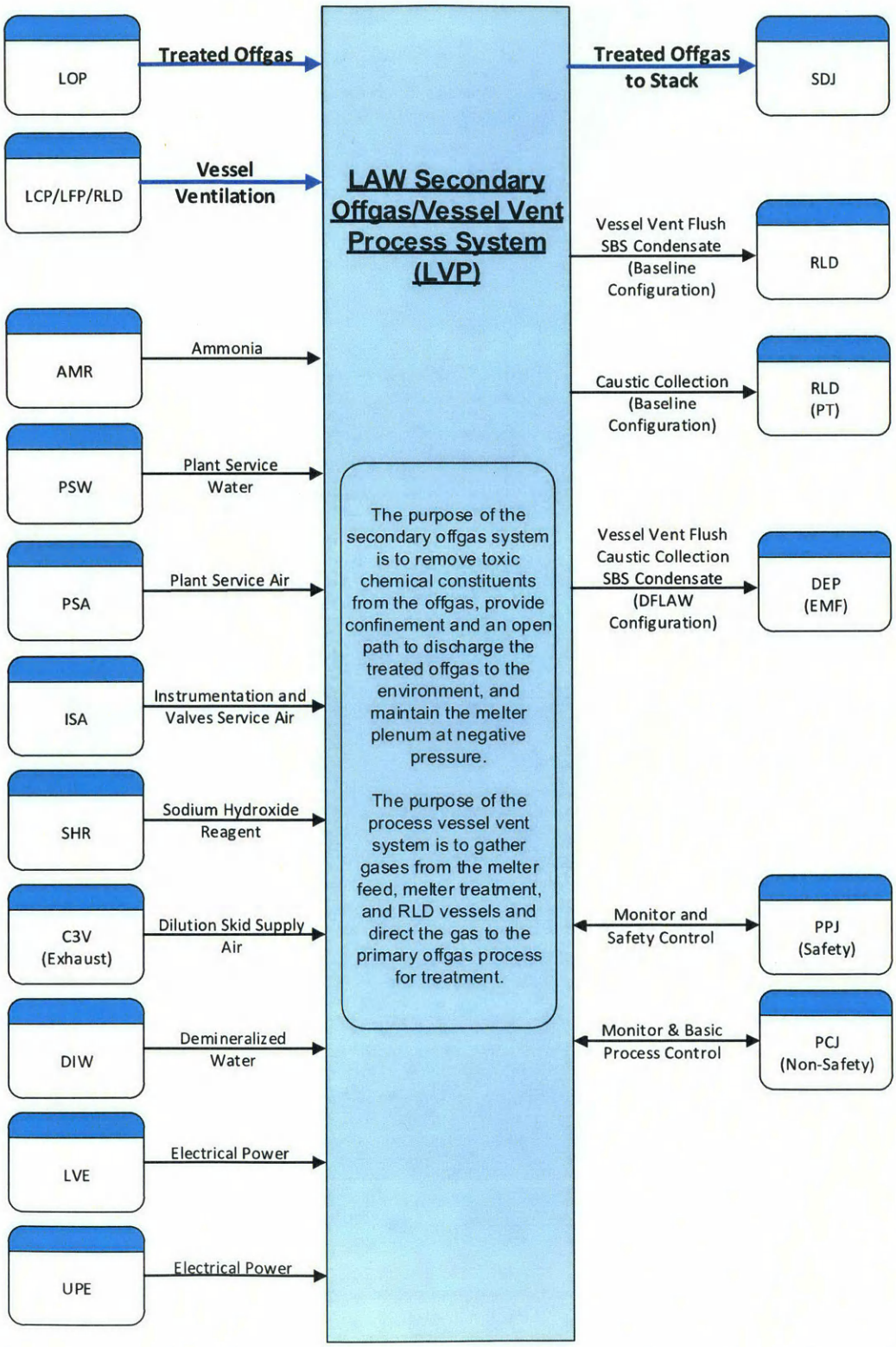


Figure 2-2 LVP System Context Diagram



2.1 System Functions/Safety Functions

This section defines the LOP and LVP functions and attributes that need to be addressed by the system design. Figure 2-3 provides the functional block diagram for the LOP and LVP systems, indicating the internal and external systems and utilities that provide the primary support or interface for that function. Section 3.1 provides the design and performance design requirements to meet both functional and other requirements.

System interfaces are provided for reference only. See Section 1.5 for the list of relevant system designators.

The functions included in Figure 2-4 are the primary and secondary level functions of the LOP and LVP systems. These functions are further described in Table 2-1, Functional Analysis and Crosswalk Requirements. Where appropriate to support definition of functional and design requirements, functions have been further decomposed and additional levels of supporting functions are also described. The requirement section number provides the location of the applicable functional analysis incorporated into system requirements.

Appendix B provides a further decomposition of system functions, including initiating, terminating, and integrating events and functions.

Figure 2-3 Functional Block Diagram

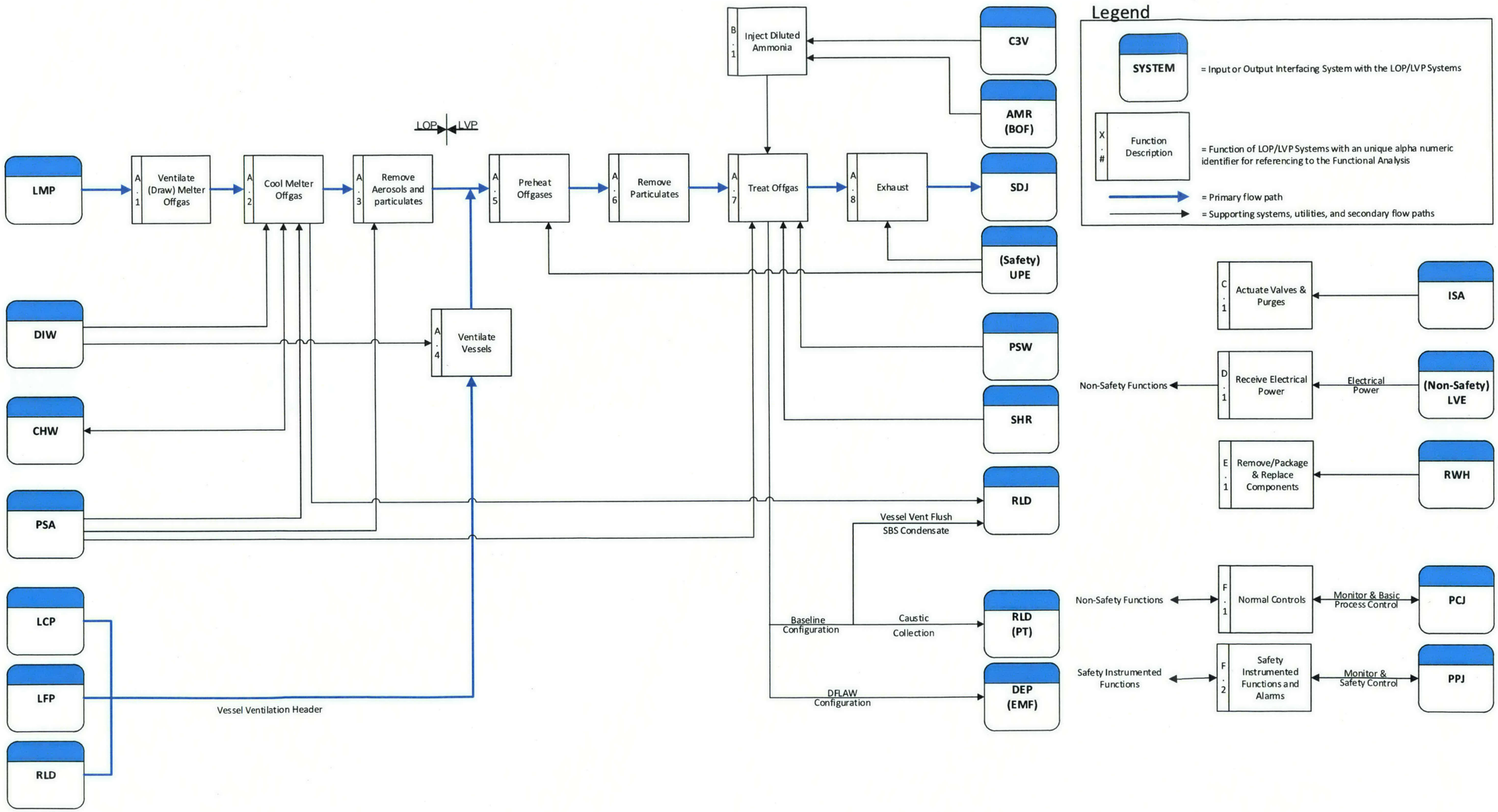


Figure 2-4 LOP and LVP Simplified Process Flow Diagram

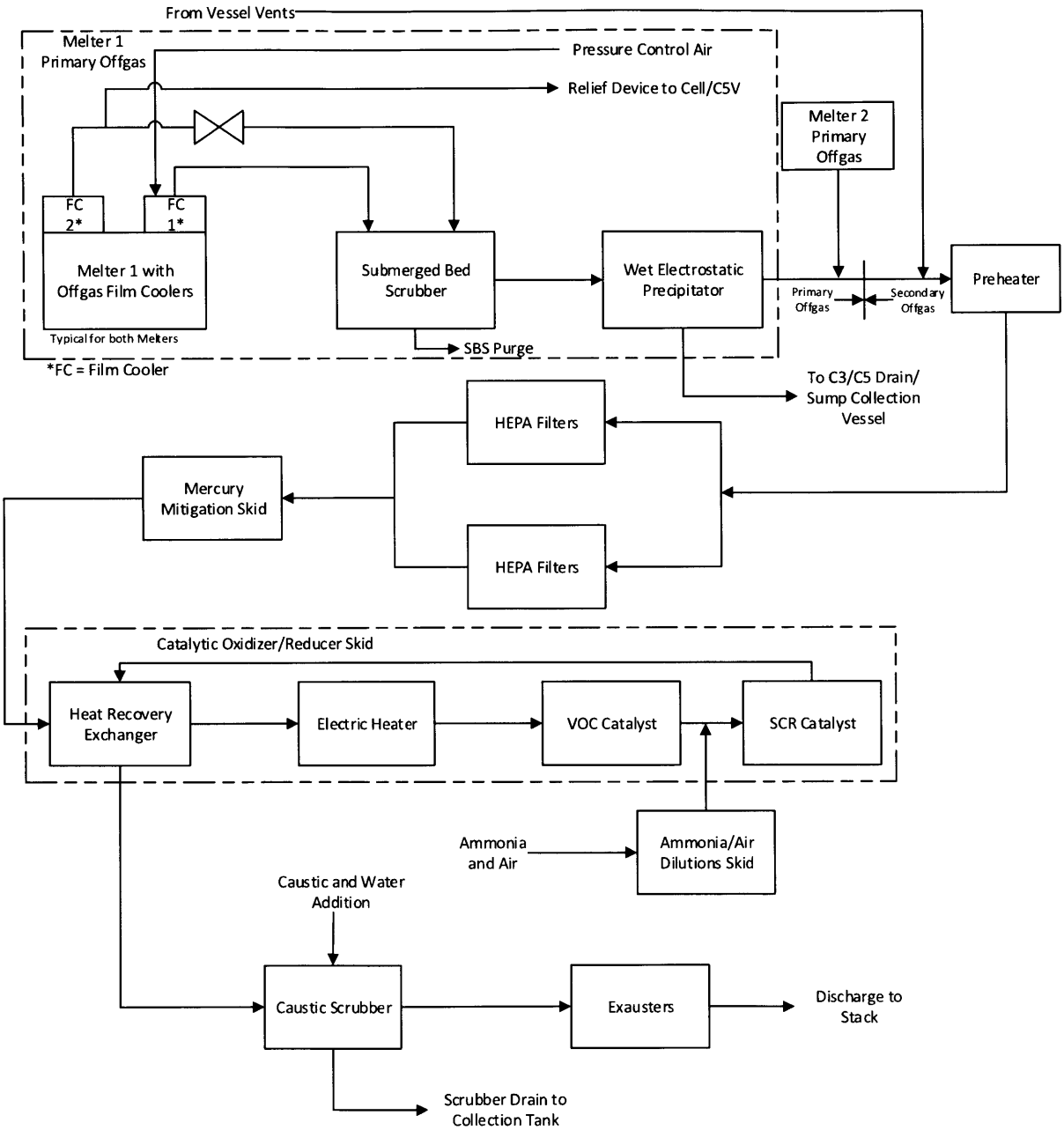


Table 2-1 Functional Analysis and Crosswalk Requirements

Reference	Functional Analysis Description	Requirement Section No.
A.	**Safely treat melter offgas to protect the public, environment, and plant personnel from radionuclide and chemical exposure.**	N/A
A.1	Ventilate (Draw) Melter Offgas – The LOP system draws gases from the melters, maintains a negative pressure in the melter plenums, equipment, and piping relative to adjacent areas, and confines hazardous.	3.4.1.1, 3.4.2.15, 3.4.2.16
A.2	Cool Melter Offgas – The LOP system cools the offgas enabling subsequent treatment. Cooling is performed by the offgas film cooler and submerged bed scrubber (SBS).	3.4.2.1
A.3	Remove Particulates and Aerosols – Remove radioactive entrained particulates and aerosols from the offgas stream via the SBS and WESP.	3.4.1.2, 3.4.1.3, 3.4.2.1, 3.4.2.5, 3.4.2.6
A.4	Ventilate Vessels –Ventilate process system vessels (LCP, LFP, and RLD).	3.4.3
A.5	Preheat Offgas –Preheat offgas stream prior to the high-efficiency particulate air (HEPA) filters to prevent moisture condensation and subsequent blinding of the HEPA filters.	3.4.2.1
A.5.1	Receive Safety Power –HEPA filter preheater safety elements receive safety power to maintain confinement and prevent moisture condensation and subsequent blinding of the HEPA filters during a loss of power event.	3.4.3
A.6	Remove Particulates – Remove radioactive-entrained particulates from the offgas stream via HEPA filters.	3.4.1.2, 3.4.2.1, 3.4.2.3, 3.4.2.5, 3.4.2.6
A.7	Treat offgas –Treat offgas to remove principal organic dangerous constituents (PODCs) and hazardous emissions in accordance with the air permit.	3.4.1.2, 3.4.1.3, 3.4.2.1, 3.4.2.2, 3.4.2.3, 3.4.2.4, 3.4.2.7, 3.4.2.8, 3.4.2.9, 3.4.2.10, 3.4.2.11, 3.4.2.12, 3.4.2.13, 3.4.2.14
A.7.1	Transfer scrubber effluents –Transfer scrubber effluents to the caustic collection vessel. Scrubber effluent collected by the caustic collection vessel is sent to either the RLD system in PT facility (baseline configuration) or the DEP system in the EMF (DFLAW configuration) for further treatment/disposal.	3.4.3.3
A.8	Exhaust – The LOP and LVP systems maintain all components at a lower pressure relative to the room or gallery in which they reside. One set of fans and air injection provide the motive force for the elevated release of offgas through the exhaust stack.	3.4.1.7, 3.10.2.1
A.8.1	Receive Safety Power – Offgas exhauster fans receive safety power to maintain offgas at a negative pressure for confinement during a loss of site power.	3.4.3
B.	**Provide Diluted Ammonia**	N/A
B.1	Inject Diluted Ammonia – Inject Diluted Ammonia/air mixture into the catalytic oxidizer/reducer skid (SCO) to reduce NO_x to nitrogen and water vapor.	3.4.2.1, 3.4.2.4
C.	**Actuate Valves**	N/A
C.1	Actuate Valves – ISA provides the motive force to safety and non-safety valves on the LOP and LVP systems and supply instrumentation purge for the LVP system.	3.4.3

Reference	Functional Analysis Description	Requirement Section No.
D.	**Electrical Power**	N/A
D.1	Receive Electrical Power - The low voltage electrical (480/208/120 V) system (LVE) provides electrical power to the non-safety LOP/LVP equipment and instruments.	3.4.3
E.	**Maintainability**	N/A
E.1	Remove/Package & Replace Components – Remove, package, and replace LOP and LVP replaceable components.	3.4.4.1
F.	**Support Monitoring, Control, and Communication Functions**	N/A
F.1	PCJ – Normal Controls	N/A
F.1.1	The non-safety LOP/LVP processes support monitoring and control communications.	3.4.3
F.2	PPJ - Safety Instrumented Functions and Alarms	N/A
F.2.1	Film Coolers High Outlet Temperature: A temperature monitor on the film cooler outlet shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**) in the film cooler outlet, the valve on the in-bleed assembly that feeds the film cooler shall actuate open.	3.9.2.2.1
F.2.2	Wet Electrostatic Precipitator (WESP) High Liquid Level: WESP level instrumentation shall be provided to detect an accumulation of liquid in the WESP. Upon detection of high liquid level (setpoint **TBD**), the WESP demineralized water flush valve shall close.	3.9.2.2.2
F.2.3	SBS High Liquid Level: SBS level instrumentation shall be provided to detect high liquid levels in the SBS vessel. Upon detection of a high liquid level in the SBS vessels, the following actions shall occur: • Shut down the operating SBS condensate purge pump • Close the isolation valves on the demineralized water connections to the bulges and priming lines associated with the SBS and SBS condensate vessels of concern. • Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.	3.9.2.2.3
F.2.4	SBS Low Liquid Level: SBS level instrumentation shall be provided to detect low liquid levels in the SBS vessel. Upon detection of a low liquid level in the SBS vessels, the following actions shall occur: • Shut down the operating SBS water purge pump • Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.	3.9.2.2.4
F.2.5	HEPA Preheaters High Outlet Temperature Interlocks: Temperature instrumentation downstream of the preheaters shall be provided to detect an increase in temperatures in the offgas stream. Upon detection of high offgas temperatures (setpoint **TBD**) downstream of the preheaters, the following actions shall occur: • Isolate power to the non-safety heating elements • De-energize the Safety heating elements on each of the Safety preheaters	3.9.2.3.1

Reference	Functional Analysis Description	Requirement Section No.
F.2.6	HEPA Preheater Differential Temperature Interlocks: Temperature instrumentation upstream and downstream of the preheaters shall be able to detect differential temperatures in the offgas stream. Upon detection of low differential temperatures (setpoint **TBD**), the following actions shall occur: • Isolate power to the non-safety heating elements • Energize a safety heating elements on each of the safety preheaters. • Monitors offgas differential temperature, and energizes additional safety heating elements, as necessary, to achieve a minimum differential temperature.	3.9.2.3.2
F.2.7	HEPA High Differential Pressure Interlock: HEPA filter differential pressure instrumentation shall be provided to detect differential pressure changes in the offgas stream. Upon detection of high differential pressure (setpoint **TBD**), the system shall terminate feed to both melters (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.	3.9.2.3.3
F.2.8	HEPA Isolation Valves Interlock: The melter offgas HEPA filter isolation valve design shall ensure that the filter isolation valves cannot isolate both filter trains at the same time. The other non-manual isolation valves shall fail in "open" position if control signal or motive power is lost.	3.9.2.3.4
F.2.9	Mercury Mitigation Skid High Differential Pressure Interlock: Mercury mitigation skid pressure monitors shall be provided to detect high differential pressure across the skid indicative of a plugged carbon adsorber or closure of a carbon adsorber isolation valve. Upon detection of high differential pressure (setpoint **TBD**) across the skid, the mercury mitigation skid bypass valve shall be actuated open.	3.9.2.4.1
F.2.10	Mercury Mitigation Skid High Inlet Temperature Interlock: Temperature monitoring on the offgas inlet to the mercury mitigation skid shall be provided to detect hot offgas flow that may be capable of causing bulk ignition and burning of the carbon media. Upon detection of high offgas temperature (setpoint **TBD**), the following actions shall occur: • Open the mercury mitigation skid bypass valve • Close the offgas inlet valve to both carbon adsorbers.	3.9.2.4.2
F.2.11	Mercury Mitigation Skid High Differential CO_x Interlock: Carbon oxides (COx) concentration monitors shall be provided across the mercury mitigation skid to detect an increase in CO or CO_2 concentration in the offgas stream, indicative of a carbon bed fire. Upon detection of high differential CO or CO_2 concentration (setpoint **TBD**), the following actions shall occur: • Open the mercury mitigation skid bypass valve • Close the offgas inlet and outlet valves of both carbon adsorbers • Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.	3.9.2.4.3
F.2.12	SCO/SCR Skid High Differential Pressure Interlock: SCO/SCR skid differential pressure detection instrumentation shall be provided to monitor differential pressures across the skid. Upon detection of a high differential pressure (setpoint **TBD**) across the skid, the SCR/SCO skid bypass valve shall be actuated open.	3.9.2.5.1

Reference	Functional Analysis Description	Requirement Section No.
F.2.13	SCO/SCR Skid High Electric Heater Temperature Interlock: A temperature monitor downstream of the catalytic oxidizer/reducer skid heater shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**), power to the catalytic oxidizer/reducer skid heater shall be isolated.	3.9.2.5.2
F.2.14	SCO/SCR Skid High Outlet Temperature Interlock: A temperature monitor on the selective catalytic oxidizer/reducer skid outlet shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**), the following actions shall occur: • Isolate ammonia flow to the catalytic oxidizer/reducer skid • Isolate the catalytic oxidizer/reducer skid heater	3.9.2.5.3
F.2.15	SCO/SCR Skid Low Outlet Temperature Interlock: A temperature monitor on the selective catalytic oxidizer/reducer skid outlet shall be provided to detect low temperatures that could result in rapid ammonium nitrate formation. Upon detection of low temperature (setpoint **TBD**), the ammonia flow at the ammonia/air-dilution skid shall be isolated.	3.9.2.5.4
F.2.16	SCO/SCR Ammonia Supply High Flow Interlock: Ammonia supply flow instrumentation shall be provided to detect a rise in ammonia supply flow. Upon detection of a high ammonia supply flow (setpoint **TBD**), the isolation valve on the ammonia supply line shall close.	3.9.2.5.5
F.2.17	SCO/SCR Ammonia Supply Low/Reverse Dilution Air Flow Interlock: Dilution-air flow instrumentation shall be provided to detect decreased/reverse dilution-air flow. Upon detection of decreased/reverse dilution-air flow (setpoint **TBD**), the isolation valve on the ammonia supply line shall close.	3.9.2.5.6
F.2.18	Caustic Scrubber High Differential Pressure Interlocks: Caustic scrubber pressure detection instrumentation shall be provided to monitor differential pressures. Upon detection of high differential (setpoint **TBD**), the following actions shall occur: • Close the caustic scrubber isolation valve on the recirculation line from the caustic collection tank • Close the caustic scrubber spray water addition control valve • Open the caustic scrubber bypass valve	3.9.2.6.1
F.2.19	Caustic Scrubber Recirculation Line Low Pressure Interlocks: Recirculation line pressure detection instrumentation shall be provided to monitor caustic scrubber recirculation line pressure. Upon detection of low pressure (setpoint **TBD**) in the recirculation line the recirculation line isolation valve shall be closed.	3.9.2.6.2
F.2.20	Caustic Scrubber Recirculation Line Low Flow Interlocks: Recirculation line flow detection instrumentation shall be provided to monitor caustic scrubber recirculation line flow. Upon detection of low flow (setpoint **TBD**), feed to the operating melter shall be terminated (LFP/LCP systems). The method of feed termination is by isolating air and water to the melter feed ADS pumps. A timed delay in water isolation is allowed for flushing activities, with related analytical limits and setpoints accounting for this time delay.	3.9.2.6.3

Reference	Functional Analysis Description	Requirement Section No.
F.2.21	Caustic Scrubber Bypass Valve Not Closed: A position switch on the caustic scrubber bypass valve shall be provided to monitor the position of the valve. Upon detection of the caustic scrubber bypass valve no longer being closed, the following actions shall occur: • Isolate power to the catalytic oxidizer electric heater • Isolate the ammonia supply to the SCO/SCR skid • Open the SCO/SCR bypass valve	3.9.2.6.4
F.2.22	Caustic Scrubber High Outlet Temperature Interlock: Temperature instrumentation downstream of the caustic scrubber unit outlet shall be provided to monitor offgas temperatures. Upon detection of high temperature (setpoint **TBD**) downstream of the caustic scrubber unit outlet, the following actions shall occur: • Isolate power to the catalytic oxidizer electric heater • Isolate the ammonia supply to the SCO/SCR skid • Open the SCO/SCR skid bypass valve.	3.9.2.6.5
F.2.23	Caustic Scrubber Low Pressure Water Supply Interlock: Process water line pressure detection instrumentation shall be provided to monitor process water line pressure. Upon detection of low pressure (setpoint **TBD**) in the process water line, the process water line isolation valve shall be closed.	3.9.2.6.6
F.2.24	LVP Low Header Vacuum Interlock: LVP header pressure detection instrumentation shall be provided to monitor the header vacuum. Upon detection of low vacuum levels (setpoint **TBD**), the following actions shall occur: • Set exhausters to a fixed speed • Open the bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber) • Close the vessel vent header pressure control valve • Terminate feed to the melters (LFP/LCP systems). The method of feed termination is by isolating air and water to the melter feed ADS pumps. • Close the isolation valve on the ammonia supply to the SCR • Close the isolation valve on the dilution-air supply to the SCR	3.9.2.7.1
F.2.25	LVP Excessive Header Vacuum Interlock: LVP header pressure detection instrumentation shall be provided to monitor the header vacuum. Upon detection of excessive vacuum levels (setpoint **TBD**), the following actions shall occur: • Set exhausters to a fixed speed • Open the bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber) • Close the vessel vent header pressure control valve • Close the isolation valve on the ammonia supply to the SCR • Close the isolation valve on the dilution-air supply to the SCR	3.9.2.7.2
F.2.26	Exhauster Normal Air Purge Low Pressure Interlock: Pressure detection instrumentation on the normal purge air supply to the exhauster shaft seals shall be provided to monitor pressure levels. Upon detection of low pressure in the normal purge air supply, the following actions shall occur: • Close the isolation valve between the exhauster shaft seals and the normal air purge supply • Open the isolation valve between the exhauster shaft seals and the backup air purge supply	3.9.2.8.1

Reference	Functional Analysis Description	Requirement Section No.
F.2.27	Exhauster Backup Air Purge Low Pressure Interlock: Pressure detection instrumentation on the backup purge air supply to the exhauster shaft seals shall be provided to monitor pressure levels. Upon detection of low pressure in the backup purge air supply, feed to both LAW melters shall be terminated (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.	3.9.2.8.2
F.2.28	LPM Melter Plenum High Pressure Interlock: Upon receipt of a high melter plenum pressure (reduced vacuum) signal from the LMP system (via PPJ), the LOP system shall take the following actions: • Stop injection of process air to the melter film coolers • Stop demineralized water flow to the melter film coolers • Stop injection of process air to the WESP • Open isolation valves on the standby offgas line	3.9.2.9.1
F.2.29	UPE Loss of Normal Power Interlock: Upon receipt of a loss of normal power signal from the UPE system (via PPJ), the LOP and LVP systems shall take the following actions: • Stop injection of process air to the melter film coolers • Stop demineralized water flow to the melter film coolers • Stop injection of process air to the WESP • Fully open the melter offgas flow control valve, downstream of the WESP • Close the vessel vent header pressure control. A bypass line around the valve with an orifice exists, allowing a limited flow from the process vessels. This limited flow is allowed for in the control strategy selection. • Open bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber)	3.9.2.10.1

2.2 System Classification

The LOP and LVP Vent Systems contain components with the following classifications/designations:

- ☐ Safety Class
- ☒ Safety Significant
- ☒ Dangerous Waste Permit affecting
- ☒ Air Permit affecting
- ☐ Waste Acceptance Impacting
- ☒ General

2.3 Basic Operational Overview

A functional description of the system is provided in Sections 2 and 2.1, which provide the context diagram for the system, interfaces with other systems, a simplified system diagram, a functional block diagram, and descriptions of the system functions. Detailed operational information is provided in Section 4.

The LOP and LVP systems are located in the LAW Facility. While WTP is operating in either the baseline or DFLAW configurations, the LOP system is the primary offgas treatment system. The offgas stream leaving the melter first enters a film cooler to cool the offgas stream in preparation for future processing. The offgas stream then enters a submerged bed scrubber (SBS) unit that is used for removal of radioactive aerosols and entrained particulate. The liquid waste from the SBS is transferred to the SBS condensate collection vessel (either directly or via the SBS overflow vessel) in the radioactive liquid waste disposal system (RLD) within the LAW Facility. The offgas stream continues to the wet electrostatic precipitator (WESP) which allows for further particulate removal. The liquid waste from the WESP is transferred to the C3/C5 drains/sump collection vessel in the LAW RLD system.

After treatment in the WESP, the offgas stream then continues to the LAW LVP system. It first enters a preheater unit to remove any moisture in the offgas stream before entering the high efficiency particulate air (HEPA) filters. The HEPA filters then remove radioactive particulate from the dried offgas stream. Upon exiting the HEPA filters, the offgas stream is sent to a mercury adsorber skid, which uses activated carbon to remove mercury, acid gases (halides), and iodine for the control of emissions. The offgas stream proceeds to a selective catalytic oxidizer (SCO) skid, where platinum-based material deposited on a cordierite ceramic monolith is used as the catalyst to oxidize volatile organic compounds (VOCs) and carbon monoxide to water vapor and carbon dioxide. Ammonia vapor is then injected into the offgas stream, and when passed through the SCR catalyst, vanadia / titania-based material deposited on cordierite ceramic converts NO_x gases into nitrogen gas and water. Finally, the offgas stream enters a caustic scrubber unit to further reduce acid gas levels. The caustic scrubber unit also cools the offgas stream, which is then exhausted from the building stack by turbine exhausters. The liquid effluents from the caustic scrubber are collected in the caustic collection vessel and transferred to the RLD system within the PT Facility.

While operating in the DFLAW configuration, all primary and secondary melter offgas treatment follows the same process as in the baseline configuration, but with two differences related to interfacing systems. The liquid effluents from the SBS and WESP are still collected in the RLD system within LAW, but are transferred to the evaporator feed vessel in the effluent management facility (EMF). The liquid effluents from the caustic scrubber unit are still collected in the caustic collection vessel, but are transferred to the overhead sampling vessels within the EMF DEP process system instead of the RLD vessels within the PT Facility. Routing of the secondary

effluents produced by the LOP/LVP systems to EMF supports operation of the LAW facility in DFLAW configuration.

The LOP/LVP systems protect the public, co-located worker, facility worker, and environment from radionuclide and chemical exposure by confining and removing hazardous radioactive and chemical components from the melter and vessel ventilation offgas. Compliance with offgas environmental treatment requirements is achieved before release from an LAW vitrification facility stack. The LOP/LVP systems also confine chemical gases and contains hazardous liquids in the offgas treatment process. Compliance with environmental monitoring and reporting is provided through the stack discharge monitoring (SDJ) system.

3 Design Requirements

3.1 Requirements

Requirements are documented in Section 3. Each requirement statement is accompanied by a basis discussion (as needed) and the expected means of verification. Requirements must be met in design. If a requirement stated in this document cannot be met in design, a revision to the requirement needs to be pursued, if possible, or the design must be changed to meet the requirement.

Requirements preceded by "**[HOLD]**" may only be used in support of preliminary or committed design, which shall also be issued with appropriate holds per procedure 24590-WTP-3DP-G04B-00046, *Engineering Drawings*. These requirements may not be used in support of fabrication or construction.

The following abbreviations are used to designate the selected method for verification (see 24590-WTP-3DP-G04B-00092, *System Verification*, for additional guidance concerning methods of verification):

(A)	Analysis
(I)	Inspection
(R)	Review
(T)	Test

The following abbreviations are used to designate the organization responsible for performing the verification:

(COM)	Commissioning
(CON)	Construction
(ENG)	Engineering
(SU)	Startup
(SUP)	Supplier
(SUB)	Subcontractor
(SQR)	Supplier Quality Representative
(REC)	Receiving

3.2 Bases

Basis discussions are provided as needed to explain the decomposition or interpretation from the originating source requirement(s). Where a **[HOLD]** has been applied to a requirement, this section will include the basis for the "HOLD."

3.3 References

The requirements include a source document reference and an identification number (ID) included in brackets following the requirement statement. Each unique source document reference, with ID number(s), is bracketed separately. Requirements may include a reference to Section 2 or 2.1, Functional Description, listed in parentheses following the source document and ID number references. A complete listing of all source references is provided in Section 5.

3.4 General Requirements

3.4.1 Mission and Functional / Performance Requirements (Including States and Modes)

The requirements include a source document reference. Each unique source document reference is bracketed separately. Requirements may include a reference to Section 2.1, *System Functions/Safety Functions*, listed in parentheses following the source document. A complete listing of all source references is provided in Section 5.1.

3.4.1.1 Primary Confinement System

Requirement: The LOP and LVP systems primary confinement system shall be composed of a locally shielded enclosure and a dedicated ventilation system associated with each melter that provides primary confinement. [Section 12.3.1.1, BOD] (A.1)

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify the boundary of the LOP/LVP primary confinement system.	

3.4.1.2 System Configuration Primary Offgas

Requirement: The LOP system shall be capable of removing particulate matter and acid gases that carry over from the melter. [Section 6.1.2, BOD] [Section C.7 (d) (3) (iii), DOE-BNI Contract] (A.3, A.6, A.7)

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the system to remove particular matter and acid gases.	May be documented in assessment/evaluation report.

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the ability of the system to remove particular matter and acid gases.	

3.4.1.3 System Configuration Secondary Offgas

Requirement: The LVP system shall be capable of destroying or removing mercury, organic compounds, oxides of nitrogen, iodine, and acid gases. [Section 6.1.2, BOD] [Section C.7 (d) (3) (iii), DOE-BNI Contract] (A.3, A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the system to remove or destroy mercury, organic compounds, and oxides of nitrogen, iodine, and acid gases.	May be documented in assessment/evaluation report.
R	ENG	Review design to verity the ability of the system to remove or destroy mercury, organic compounds, and oxides of nitrogen, iodine, and acid gases.	

3.4.1.4 Room Environment Conditions for Safety SSCs

Requirement: The safety equipment in the LAW Facility LOP and LVP system credited with any safety function(s) and post-accident monitoring instruments shall be designed and qualified to perform their safety function(s) as intended in the environment conditions associated with the events for which they are intended to respond, inclusive of aging effects, throughout their qualified life. [Safety Criterion 4.1-3, Safety Criterion 4.4-1, SRD] [Section 11.7.3, BOD] [Section 11.16, ORD]

Basis discussion: SSCs designated as safety significant (SS) are designed and qualified to perform their safety function(s) as intended in the room environment conditions associated with the events for which they are intended to respond. The effects of aging on normal and abnormal functioning are considered in design and qualification. 24590-LAW-U0D-W16T-00001, *LAW Room Environment Data Sheet* identifies environmental conditions for rooms that house safety SSCs. 24590-LAW-RPT-ENS-12-001, *LAW Post Accident Monitoring Report* identifies PAM instrumentation.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing to verify the ability of the SSCs credited with a safety function to withstand the specified environmental conditions.	Document in EQP. See 24590-LAW-U0D-W16T-00001, *LAW Room Environment Data Sheet* for room environmental conditions.
R	ENG	Review the design to verify conformance to the as-tested or as-analyzed configuration.	Document in an evaluation/assessment or EQP

3.4.1.5 Minimum Design Life

Requirement: The LOP and LVP components listed in the table below shall be designed to operate, and provide primary containment/confinement where that is a function of the component, for a minimum design life as indicated inclusive of maintenance. [Section C.7, WTP Contract] [Section 11.1.1, BOD] [Sections 14.1, 14.2 ORD]

Table 3-1 LOP and LVP Equipment and Components Design Life

Equipment/Component Description	Design Life (Years)
SBS	40
SBS Condensate Vessel	40
WESP, vessel	40
HEPA Electric Preheater (Housing)	40
Mercury Mitigation Skid	40
Catalyst Skid Preheater	40
Catalyst Skid Electric Heater (Housing)	40
Selective Catalyst Oxidizer	40
Selective Catalytic Reducer	40
Extraction Fans	40
Film Cooler	>5
Dampers	40
Damper internals	>5
Jumpers inclusive of in-line components (Mechanical, Instrument Air, and Electrical)	Target design life >5

Basis Discussion: System equipment not listed have not been assigned a required design life. Engineering judgment and tools such as trade studies and life-cycle cost analysis are expected to be used to maximize system availability and reduce maintenance costs. All equipment whose failure would result in complete or partial system outage with the potential to disrupt plant operations should be designed to last a minimum of 5 years without significant maintenance or replacement that would require the equipment to be removed from service (i.e. calibration would not be considered major maintenance, because it does not require the equipment to be physically removed from service); this reduces the risk of an unplanned outage and lost glass production, reduces waste, and minimizes personnel exposure. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	The "qualified" design life for safety SSCs is to be verified through equipment environmental qualification documentation that may be accomplished through analysis or testing.	Document verification in equipment qualification package (EQP) and through supplier/subcontractor certificate of conformance.
R	ENG	Verify the supplier certificate of conformance versus design life requirement established in the material requisition (specification or datasheet) for non-safety SSCs.	

3.4.1.6 Materials of Construction and Erosion/Corrosion Design Parameters

Requirement: The LOP and LVP systems' shall be designed to include adequate allowance for erosion/corrosion and use materials of construction in accordance with Appendix H of the SRD: [Appendix H, Section 5, SRD]

Basis Discussion: The allowance for erosion/corrosion and applicable materials of construction are limited to those components that come into contact with the process fluids and that are required to maintain confinement/containment of those process fluids. Materials of construction that can withstand the erosive/corrosive low-activity waste effluents and chemicals are selected. The materials for the LAW Facility LOP and LVP system equipment and components are selected based on the stream data presented in the process corrosion data sheet report. If flushing or washing via internal spray mechanisms is needed to prevent or minimize corrosion, the operational limitations are identified in the corrosion evaluation. Refer to Appendix B, Tables B-25 to B-28; 24590-WTP-DB-PET-09-001, *Process Inputs Basis of Design* (PIBOD); and 24590-WTP-M4C-V11T-00024, *WTP Process Flowsheet Mass & Energy Balance Analysis for Input to Material Selection Assessments,* for the fluid characteristics of the process streams.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/R	ENG	Perform an analysis/review of materials used in the LAW Facility LOP and LVP systems which are in contact with, and are required to maintain confinement or containment of, the process fluids to verify that they are acceptable for use in the operating environment and have adequate erosion and corrosion allowances.	Details of the allowed materials and corrosion allowances can be found in: • 24590-LAW-N1D-LOP-00001, *LOP-SCB-00001 and LOP-SCB-00002 - LAW- - Melter 1 and Melter 2 Submerged Bed Scrubbers (SBS)* • 24590-LAW-N1D-LOP-00002, *LOP-VSL-00001 and LOP-VSL-00002 - LAW- Melter 1 and Melter 2 SBS Condensate Vessel* • 24590-LAW-N1D-LOP-00003, *LOP-WESP-00001 and LOP-WESP-00002 LAW – Melter 1 and Melter 2 Wet Electrostatic Precipitator WESP* • 24590-LAW-N1D-LOP-00004, *Corrosion Evaluation - LOP-Offgas*

Verif. Method	Verif. By	Plan	Notes/Comments
			Piping (Downstream of Film Cooler to SBS Entry) • 24590-LAW-N1D-LOP-00006, *LOP-PMP-00001 and 2 and 4 and 5 LAW – Melter 1 and 2 SBS Condensate Purge Pumps* • 24590-LAW-N1D-LOP-00007, *LOP-PMP-00003A-B & LOP-PMP-00006A-B Melter 1 & 2 SBS Water Purge Pump – Primary & Standby* • 24590-LAW-N1D-LOP-P0001, *LOP-SCB-00001 & LOP-SCB-00002 (LAW) Melter 1 and Melter 2 Submerged Bed Scrubbers (SBS)* • 24590-LAW-N1D-LOP-P0002, *LOP-VSL-00001 & LOP-VSL-00002 (LAW) Melter 1 & Melter 2 SBS Condensate Vessel* • 24590-LAW-N1D-LOP-P0003, *LOP-WESP-00001 & LOP-WESP-00002 (LAW) Melter 1 and Melter 2 Wet Electrostatic Precipitator (WESP)* • 24590-LAW-N1D-LOP-P0004, *Plant Item Material Selection Data Sheet* • 24590-LAW-N1D-LVP-00001, *LVP-SCB-00001 (LAW) - LAW Melter Offgas Caustic Scrubber – Corrosion Evaluation* • 24590-LAW-N1D-LVP-00002, *LVP-TK-00001 LAW – Caustic Collection Tank* • 24590-LAW-N1D-LVP-00003, *LVP-EXHR-00001A/B/C (LAW) Melter Offgas Exhauster* • 24590-LAW-N1D-LVP-00004, *LVP-ADBR-00001A/B (LAW) Activated Carbon Bed Adsorber* • 24590-LAW-N1D-LVP-00005, *LVP-HX-00001 – Catalytic Oxidizer Heat Recovery Exchanger* • 24590-LAW-N1D-LVP-00006, *LVP-HTR-00002 - Catalytic Oxidizer Electric Heater* • 24590-LAW-N1D-LVP-00007, *LVP-SCO-00001 - Thermal Catalytic Oxidizer* • 24590-LAW-N1D-LVP-00008, *LVP-SCR-00001 - NO_x Selective Catalytic Reducer*

Verif. Method	Verif. By	Plan	Notes/Comments
			• 24590-LAW-N1D-LVP-00009, *LVP-HTR-00001A&B & LVP-HTR-00003A/B (LAW) – Melters Offgas HEPA Preheater* • 24590-LAW-N1D-LVP-P0002, *LVP-TK-00001 (LAW)*
R	**ENG**	Review design to verify components used in the LAW Facility LOP and LVP systems which are in contact with, and are required to maintain confinement or containment of, the process fluids for concurrence with analysis.	

3.4.1.7 Vessel Vent and Melter Offgas Discharge Flue

Requirement: The LOP and LVP system discharge air shall be routed through a dedicated flue. [Section 12.5.6, BOD] (A.8)

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review design to verify LOP and LVP discharge air is routed through a dedicated flue.	

3.4.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.4.2.1 Demonstration of Best Available Radionuclide Control Technology (BARCT)

Requirement: The LOP and LVP systems shall use and demonstrate Best Available Radionuclide Control Technology (BARCT) (WAC 246-247-040). [Section 14.3.1, BOD] (A.7)

Basis Discussion: In accordance with NOC 627, *DOH Radioactive Air Emissions NOC for Construction of the WTP LAW Vitrification Plant:* LV-S3-04, the WDOH has determined that BARCT for emission unit LV-S3 (LAW) is a system comprising the following control technology, ancillary equipment, protective features, and protective equipment, in the following order: a film cooler, a Submerged Bed Scrubber (SBS), a Wet Electrostatic Precipitator (WESP), an injection of air delivered through a Vessel Vent Header (S52 Stream), a Heater, two stages of High-Efficiency Particulate Air (HEPA) filtration in series, Carbon Bed Adsorber, and C3 dilution air HEPA filter for the NON-BARCT Selective Catalytic Reduction Unit ammonia injection system and exhaust fans. Control technologies for operation of the LAW emission unit that are not regulated by this license (located between the Carbon Bed Adsorber and the Stack) are a Heat Exchanger, a Heater, a Catalytic Oxidizer, two Selective Catalytic Reduction (SCR) units off-gas is then routed back through the Heat Exchanger, and a Caustic Scrubber. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design and vendor data to verify conformance with the BARCT requirements in the air permit.	May be documented in assessment/evaluation report.

3.4.2.2 Demonstration of Best Available Control Technology (BACT)

Requirement: The design of the WTP offgas systems must demonstrate best available control technology (BACT) for the criteria pollutants, as specified in WAC 173-400. [Section 14.4.1, BOD] (A.7)

Basis Discussion: In accordance with PSD Approval No. PSD-02-01, selective catalytic reduction has been determined to be BACT for the control of NO_x emissions from the LAW vitrification facility. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design and vendor data to verify conformance with the BACT requirements in the air permit.	May be documented in assessment/evaluation report.

3.4.2.3 Demonstration of Best Available Control Technology for Toxic Air Pollutants (T-BACT)

Requirement: The design of the WTP offgas systems must also demonstrate BACT for toxic air pollutants, as specified by WAC 173-460. A new source that is likely to increase toxic air pollutant (TAP) emissions shall not be established or operated without installing and operating best available control technology for toxic air pollutants (T-BACT) (WAC 173-460-060). The TAPs that have been determined to be applicable to WTP are listed in the Notice of Construction Approval Order, DE02NWP-002. [Section 14.4.3.1, 14.4.3.2, 14.4.3.3, BOD] (A.6, A.7)

Basis Discussion: In accordance with the *Notice of Construction Approval Order DE02NWP-002:*

- **T-BACT for Particulates and Aerosols:** High efficiency particulate air (HEPA) filters with a removal efficiency of 99.95 % for single stage filtration and 99.9995 % for two-stage filtration are T-BACT for the control of particulates and aerosols in the process facilities. The off-gasses from the LAW melters are characterized as high temperature streams. Therefore, the additional equipment, such as quenching and mist elimination equipment, will be required to protect the HEPA filters in the LAW vitrification plant.
- **T-BACT for Acid Gases:** The selected T-BACT for acid gas control in the LAW facility are carbon adsorbers for halide gases and caustic scrubbers for SO_x control. Each will achieve a removal efficiency of 97 %.
- **T-BACT for Volatile Organic Compounds (VOCs):** Oxidizers with a removal efficiency of 99 % or selective catalytic oxidizers with a removal efficiency of 95 % are T-BACT for the control of VOCs in the LAW vitrification plant.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design and vendor data to verify conformance with the T-BACT requirements in the air permit.	May be documented in assessment/evaluation report.

3.4.2.4 Treatment of NO_x Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure NO_x emissions do not exceed 477 parts per million dry by volume (ppmdv) at 21 % oxygen (O_2) averaged over 24 consecutive hours or 200.1 pounds per day averaged over 30 consecutive days. [Approval Condition 4, PSD Air Permit] (A.7, B.1)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure NO_x emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify the NO_x emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.5 Treatment PM10 Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure PM or PM10 emissions do not exceed 0.36 pounds per hour at 21 % O_2, when averaged over 24 consecutive hours. [Approval Condition 3, PSD-02-01, PSD Air Permit] (A.3, A.6)

Basis Discussion: PM10 is the measurement of particulates smaller than 10 microns. Initial testing is required to be performed within 60 days of achieving hot commissioning, but no later than 180 days of startup. Use of HEPA filtration in design is expected to ensure exhaust conforms to emissions limits.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability to sample the offgas for PM10 emissions per 40 CFR 60, Appendix A, Methods 1-5.	May be documented in assessment/evaluation report.
T	SU/ COM	Test per 40 CFR 60, Appendix A, Methods 1-5, including verification that PM10 emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.6 Particulate Matter Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure particulate matter emissions do not exceed 34 mg/dscm (0.015 grains/dscf). [Section III.10.H.1.b.ii, WTP Dangerous Waste Permit] (A.3, A.6)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure particulate emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify particulate emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.7 Hydrochloric Acid and Chlorine Gas Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure hydrochloric acid and chlorine gas emissions do not exceed 21 ppmv, combined. [Section III.10.H.1.b.iii, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure hydrochloric acid and chlorine gas emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify hydrochloric acid and chlorine gas emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.8 Dioxin and Furan Toxicity Equivalence Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure dioxin and furan toxicity equivalence (TEQ) emissions do not exceed 0.2 nanograms (ng)/dscm. [Section III.10.I.1.b.iv, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure dioxin and furan TEQ emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify dioxin and furan TEQ emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.9 Mercury Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure mercury emissions do not exceed 45 μg/dscm. [III.10.H.1.b.v, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure mercury emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify mercury emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.10 Lead and Cadmium Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure lead and cadmium emissions do not exceed 120 μg/dscm, combined. [Section III.10.H.1.b.vi. WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure lead and cadmium emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify lead and cadmium emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.11 Arsenic, Beryllium, and Chromium Emissions

Requirement: The LOP and LVP systems' equipment shall be designed to ensure arsenic, beryllium, and chromium emissions do not exceed 97 μg/dscm, combined. [Section III.10.H.1.b.vii, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure arsenic, beryllium, and chromium emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify arsenic, beryllium and chromium emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.12 Carbon Monoxide Emission

Requirement: The LOP and LVP systems' equipment shall be designed to ensure CO emission do not exceed 100 ppm by volume, over an hourly rolling average, dry basis. [Section III.10.H.1.b.viii, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure carbon monoxide (CO) emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify carbon monoxide emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.13 Hydrocarbon Emission

Requirement: The LOP and LVP systems' equipment shall be designed to ensure hydrocarbon emission do not exceed 10 ppm by volume, over an hourly rolling average, dry basis, and reported as propane. [Section III.10.H.1.b.ix, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure hydrocarbon emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify hydrocarbon emissions are within limits.	In accordance with ecology approved test plan.

3.4.2.14 Organic Compound Destruction

Requirement: The LOP and LVP systems' equipment shall be designed to ensure a minimum destruction and removal efficiency (DRE) of 99.99 % for the principal organic dangerous constituents (PODC) listed in [40 CFR 63.1203(c)(1), 40 CFR 63.1203(c)(2), in accordance with WAC 173-303-680(2)]. [Section III.10.H.1.b.i, WTP Dangerous Waste Permit] (A.7)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the ability of the offgas system to ensure principal organic dangerous constituents (PODC) emissions are within limits.	May be documented in assessment/evaluation report.
T	SU/ COM	Test to verify principal organic dangerous constituents are within limits.	In accordance with ecology approved test plan.

3.4.2.15 Melter Surges

Requirement: The Melter offgas system shall be designed to accommodate surges in the melter. [Sections 4.4.3.3, 4.4.3.5, PDSA - LAW Facility] (A.1)

Basis Discussion: Per 24590-WTP-PSAR-ESH-01-002-03, Section 4.4.3.4, ASME B31.3, *Process Piping*, will be used for the melter offgas piping, including fittings, film coolers, instrumentation interfaces that form part of the confinement boundary, and valves. An additional, alternate path has been established for the melter offgas, to ensure an unobstructed flowpath and to increase system capacity during a melter surge. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the melter offgas system design to verify capability to accommodate surges.	

3.4.2.16 Hazardous Confinement

Requirement: The following hierarchy of gaseous hazards design controls shall be applied to the LOP/LVP systems and their components relative to the control of NO_x and ammonia vapor to separate the hazard from facility personnel:

- Systems with gaseous hazards shall be located outdoors (to the extent practicable).
- Potential leak points in areas that could result in worker exposure to gases above the Short-Term Exposure Limit (STEL, per American Conference of Industrial Hygienists - ACGIH) shall be contained within ventilated enclosures.
- Piping and tubing systems containing gaseous hazards within facility buildings shall use welded joints to eliminate leak points (except where other joints/couplings are needed to support maintenance requirements).
- If potential leak points are not enclosed, evaluation of design leakage from system components and piping against designed ventilation flow through the affected room must demonstrate atmospheric concentrations remain below the STEL during normal system operation if the affected space is accessible to personnel without controls to ensure safe entry.

[Section 8.1.4.2, ORD] (A.1)

Basis Discussion: Analysis/evaluation is used to determine the design controls and the extent or scope of the selected control applied to the system. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	NSE	Perform analysis/evaluation of the potential gaseous hazards of NO_x and ammonia vapor within the LOP/LVP system boundary to determine the controls to apply to the design.	Include Operations and Industrial Safety/ Hygiene participation in the analysis / evaluation.
R	ENG	Review design to verify conformance with controls or design features selected in the analysis/evaluation.	

3.4.2.17 Caustic Scrubber Loop Seal

Requirement: The drain line from the caustic scrubber to the caustic collection tank shall contain a loop seal capable of preventing in-leakage into the melter offgas system from the caustic collection tank under bounding conditions from the downstream exhausters. [Sections 4.4.9.1, 4.4.9.3, Appendix 4A Table 4A-2, 5.6.12, PDSA - LAW Facility]

Basis Discussion: To prevent a loss of melter depression due to excessive in-leakage, a full loop seal is maintained in the drain line from the caustic scrubber to the caustic collection tank. Sufficient head is maintained in the loop seal via caustic scrubber recirculation line flow to ensure that even under the maximum expected exhauster vacuum in the melter offgas system (based on equipment locations and the presence of an open path from the melter plenum through the stack), the loop seal will continue to prevent in-leakage into the melter offgas system through this pathway. The height of the loop seal ensures that even following a loss of flow that evaporative losses will not allow for breakthrough of the line before melter feed can be terminated and the cold cap burnt off.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the presence of a loop seal in the drain line from the caustic scrubber to the caustic collection tank.	

3.4.2.18 Electrical Conduit Flood Control

Requirement: SS electrical conduit in flood zones which are connected to SS SSCs shall prevent the spread of the flood to other SS SSCs by not allowing water ingress. [Sections 4.4.3.3, 4.4.5.3, 4.4.6.3, 4.4.7.3, 4.4.8.3, 4.4.9.3, 4.4.10.3, 4.4.11.3, PDSA - LAW Facility]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design of the melter offgas SS electrical conduit to verify flood water will not enter the conduit and spread flooding to other areas.	

3.4.2.19 Safety Designations

Requirement: The LOP and LVP systems SSCs shall be designated as safety significant SSCs in accordance with the following table:

Table 3-2 LOP and LVP Safety Functions

Equipment/Component Description	Credited Safety Function	Reference
Exhaust stack offgas piping Section **3.10.2.1**	The offgas exhaust stack pipe ensures that melter offgas is released from the facility at an elevated level.	Section 4.4.1, Appendix 4A-2 LAW PDSA
Melter Offgas System piping (including SBS standby line), HEPA filter housing Section **3.4.1.1**	Offgas piping provides a confinement boundary and pathway for removal of toxic, high temperature offgas from the melters and directs it to a safe area outside the facility.	Section 4.4.3, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
Melter offgas system piping Section **3.6.2.2**	Elevation differences between the WESP and the HEPA filters prevents flooding of the HEPA filters due to liquid generated in the WESP.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Melter Offgas System exhausters and associated adjustable speed drives Section **3.8.2.1**	The offgas exhausters provide motive force to pull offgas from the melter plena and direct it through the exhaust stack.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Melter Offgas System exhausters Section **3.8.2.2** Section **3.8.2.3**	The offgas exhauster design shall ensure: 1. Two exhausters at a (reduced) fixed speed will maintain adequate depression on the melters in conjunction with other SS system reconfigurations to establish a known LOP/LVP system configuration 2. The design of the offgas exhausters must ensure that during the abnormal operating condition of a single operating exhauster on normal ICN control, the single exhauster unit can provide sufficient motive force to pull offgas from the melter plena and push it through downstream components. This is accomplished in conjunction with SS system reconfigurations, as necessary, that support the maintenance of depression in the melter.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Offgas components Section **3.4.1.1** Section **3.8.2.1**	The offgas system components (melter plenum, SBS, SBS Condensate Vessel, WESP, carbon adsorbers, selective catalytic reducer, etc.) provide an intact confinement boundary and pathway to direct offgas from the melters to the exhaust stack.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Melter offgas exhauster check valve Section **3.8.2.5**	Prevent recirculation loops if exhauster fails.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Non-manual isolation valves within the melter offgas system flowpath Section **3.9.2.3.4**	Prevent unintended restriction in melter offgas flow.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Melter offgas HEPA filter train isolation valves Section **3.9.2.3.4**	Prevent isolation of both filter trains simultaneously.	Section 4.4.3, Appendix 4A-2 LAW PDSA
HEPA filter differential pressure instrumentation and interlock Section **3.9.2.3.3**	Stop feed to the melter(s) when high differential pressure is detected across both banks of HEPA filters.	Section 4.4.3, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
Mercury mitigation skid carbon oxides monitor/carbon adsorber isolation valve interlocks Section **3.9.2.4.3**	CO_x monitors across the mercury mitigation skid are relied on to detect production of CO_x in the bed, indicative of a carbon fire. On detection of elevated differential CO_x levels above a predetermined setpoint, a signal is sent through interlocks to fully close the offgas inlet and outlet isolation valves to both carbon adsorbers. This reduces oxygen flow to the fire and mitigates the release of mercury.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Mercury mitigation skid carbon oxides monitor/melter feed termination interlocks Section **3.9.2.4.3**	CO_x monitors across the mercury mitigation skid are relied on to detect production of CO_x in the bed, indicative of a carbon fire. On detection of elevated differential CO_x levels above a predetermined setpoint, a signal is sent through interlocks to terminate feed to both melters. This begins cold cap burnoff in the event that subsequent water addition to the carbon adsorbers is made in response to the fire, which has the potential to eventually block the melter offgas flow.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Mercury mitigation skid high temperature/carbon adsorber isolation valve interlocks Section **3.9.2.4.2**	The temperature of the offgas flowing into the mercury mitigation skid is monitored. On detection of high temperature (above predetermined setpoint) the offgas inlet valves to both carbon adsorbers are closed by interlock. This control prevents bulk ignition of the carbon media due to flow of hot offgas through the carbon media. The temperature setpoint will be established at a value below the ignition temperature of the carbon media.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Mercury mitigation pressure relief path Section **3.7.4.2**	The carbon adsorbers must be provided with pressure relief devices and a relief path that vents into the offgas header to prevent excessive pressures in the carbon adsorbers.	Section 4.4.3, Appendix 4A-2 LAW PDSA
Mercury mitigation pressure relief path inleakage Section **3.7.2.3**	The combined oxygen inleakage rate into the carbon adsorbers, with isolation valves closed, must be less than the limiting value calculated in the accident analysis. The pressure relief path from the carbon adsorbers back to the secondary offgas system must be designed in a manner that limits backflow of oxygen (due to countercurrent flow or diffusion) such that the total inleakage rate used in the accident analysis is not exceeded.	Section 4.4.3, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
SBS vessel level interlocks, including associated level detection instrumentation and final elements (isolation valves and isolation contactors) Section **3.9.2.2.3**	Monitor SBS vessel level. On detected high level, provide activation signal to stop SBS condensate purge pumps, isolate the demineralized water supply to the associated melter valve bulge and SBS condensate purge pump priming lines, and terminate melter feed. On low level, provide activation signal to stop SBS water purge pumps. On low level, provide activation signal to isolate associated melter ADS air and water supply isolation valves (feed shutdown).	Section 4.4.5, Appendix 4A-2 LAW PDSA
WESP level instrumentation Section **3.9.2.2.2**	Monitor WESP level. On detected high level, provide activation signal to WESP demineralized water isolation interlock.	Section 4.4.6, Appendix 4A-2 LAW PDSA
WESP demineralized water flush valve Interlock Section **3.9.2.2.2**	Isolate water flow to WESP if the WESP drain is plugged.	Section 4.4.6, Appendix 4A-2 LAW PDSA
Catalytic oxidizer/reducer skid differential pressure instrumentation, and skid bypass valve interlocks Section **3.9.2.5.1**	Monitor differential pressure across the catalytic oxidizer/reducer skid. On detection of high differential pressure, provide activation signal to the catalytic oxidizer/reducer skid bypass valve interlock, and actuate bypass valve to maintain the offgas system flow capability.	Section 4.4.7, Appendix 4A-2 LAW PDSA
Catalytic oxidizer/reducer skid bypass valve and interlock Section **3.9.2.5.1**	Actuate bypass valve to maintain the offgas system flow capability if the differential pressure across the catalytic oxidizer/reducer skid increases to a predetermined setpoint due to plugging of components on the skid.	Section 4.4.7, Appendix 4A-2 LAW PDSA
Melter plenum pressure interlocks Section **3.9.2.9.1**	Stop injection of air to the film coolers if melter plenum vacuum is reduced to a predetermined setpoint. Stop injection of air to the WESP if melter plenum vacuum on the associated melter is reduced to a predetermined setpoint. Stop feed to the melter if melter plenum vacuum is reduced to a predetermined setpoint. Actuate open standby offgas line isolation valve to provide additional offgas system flow capability if melter plenum vacuum is reduced to a predetermined setpoint. Isolate demineralized water flow to the melter film cooler if melter plenum vacuum is reduced to a predetermined setpoint.	Section 4.4.8, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
Caustic scrubber recirculation and process water line pressure instrumentation Section **3.9.2.6.2**	Monitor line pressure. On detection of low pressure provide actuation signal to close the respective isolation valve interlock for the affected line.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Caustic scrubber recirculation and process water line isolation valves and interlocks Section **3.9.2.6.3**	Isolate potential sources of excessive in-leakage into the melter offgas system. Isolate potential sources of caustic scrubber flooding or bed flooding if the scrubber drain is plugged or overwhelmed.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Caustic scrubber recirculation line flow instrumentation and associated interlock Section **3.9.2.6.3**	Monitor line flow. On detection of low flow provide actuation signal to isolate demineralized water and plant service air feeds to the ADS pumps within the melter feed vessels, terminating feed to the melters.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Loop seal between the caustic scrubber and the caustic collection tank Section **3.4.2.17**	Prevent excessive in-leakage into the melter offgas system.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Caustic scrubber differential pressure instrumentation Section **3.9.2.6.1**	Monitor differential pressure across the caustic scrubber. On detection of high differential pressure provide activation signals to the caustic scrubber recirculation line isolation valve, caustic scrubber spray water addition valve, and caustic scrubber bypass valve interlocks.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Caustic scrubber bypass valve and interlock Section **3.9.2.6.4**	Actuate bypass valve to maintain the offgas system flow capability if the differential pressure across the caustic scrubber increases to a predetermined setpoint due to plugging or flooding of the bed.	Section 4.4.9, Appendix 4A-2 LAW PDSA
Loss of normal facility power reconfiguration interlocks and associated components Section **3.9.2.10.1**	Automatically place the melter offgas system into a configuration that allows the exhausters to maintain confinement for no less than 2 hr, upon detection of loss of normal power.	Section 4.4.10, Appendix 4A-2 LAW PDSA
Mercury mitigation skid bypass interlock Section **3.9.2.4.1**	Open bypass valve to direct melter offgas flow around the mercury mitigation skid on detection of high differential pressure across the skid, high differential CO_x concentration across the skid, or high inlet offgas temperature. (Note: The CO_x monitors and offgas temperature monitor are SS to mitigate carbon bed fires).	Section 4.4.11, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
Catalytic oxidizer/reducer skid heater interlock Section **3.9.2.5.2**	The catalytic oxidizer/reducer skid heater interlock prevents excessive temperatures that could result in a breach of the melter offgas confinement boundary and a subsequent melter offgas release event. This interlock as associated detection instrumentation detects high heater temperatures and cuts off the heater before excessive temperatures are reached.	Section 4.4.14, Appendix 4A-2 LAW PDSA
Ammonia/dilution-air supply flow isolation interlock components Section **3.9.2.5.5** Section **3.9.2.5.6** Section **3.9.2.5.7**	Isolation of ammonia flow upon indication of low/reverse dilution-air flow, loss of power or control signal, and high ammonia supply flow.	Section 4.4.16, Appendix 4A-2 LAW PDSA
SBS and SBS condensate vessel cooling line pressure relief Section **3.5.2.3**	Prevent failure of the cooling lines due to over pressurization when isolated.	Section 4.4.22, Appendix 4A-2 LAW PDSA
Selective catalytic oxidizer/reducer skid outlet high temperature interlock Section **3.9.2.5.3**	The selective catalytic oxidizer/reducer skid outlet high temperature interlock prevents excessive temperatures that could result in a breach of the melter offgas confinement boundary and a subsequent melter offgas release event.	Section 4.4.23, Appendix 4A-2 LAW PDSA
Film cooler high temperature interlock Section **3.9.2.2.1**	The film cooler high temperature interlock prevents excessive temperatures that could result in a breach of the melter offgas confinement boundary and a subsequent melter offgas release event.	Section 4.4.24, Appendix 4A-2 LAW PDSA
Melter offgas HEPA preheaters and associated interlocks Section **3.9.2.3**	Sufficiently raise temperature of offgas flow into HEPA filters to prevent moisture condensation and subsequent blinding of the HEPA filters. (LVP-HTR-00001B and 00003B) Sufficiently raise temperature of offgas flow into carbon adsorbers to prevent condensation and subsequent corrosion failure of the melter offgas system. (LVP-HTR00001B and -00003B) Prevent failure of the offgas confinement boundary due to high preheater heating element temperatures. (all LVP HEPA preheaters)	Section 4.4.32, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
LVP header low vacuum interlocks Section **3.9.2.7.1**	Set all functional melter offgas exhausters to a predetermined speed if LVP header vacuum is reduced to a predetermined setpoint. Actuate open the bypass valves around the carbon beds, SCO/SCR skid and the caustic scrubber if LVP header vacuum is reduced to a predetermined setpoint. Close the vessel vent header pressure control valve if LVP header vacuum is reduced to a predetermined setpoint. Stop feed to both melters if LVP header vacuum is reduced to a predetermined setpoint. Close isolation valves on the ammonia and dilution air supply lines to the ammonia/air dilution skid if LVP header vacuum is reduced to a predetermined setpoint.	Section 4.4.33, Appendix 4A-2 LAW PDSA
LVP header excessive vacuum interlocks Section **3.9.2.7.2**	Set all functional melter offgas exhausters to a predetermined speed if LVP header vacuum exceeds a predetermined setpoint. Actuate open the bypass valves around the carbon beds, SCO/SCR skid, and the caustic scrubber if LVP header vacuum exceeds a predetermined setpoint. Close the vessel vent header pressure control valve if LVP header vacuum exceeds a predetermined setpoint. Close isolation valves on the ammonia and dilution air supply lines to the ammonia/air dilution skid if LVP header vacuum exceeds a predetermined setpoint.	Section 4.4.34, Appendix 4A-2 LAW PDSA
Selective catalytic oxidizer/reducer skid outlet low temperature interlock Section **3.9.2.5.4**	Prevent rapid ammonium nitrate accumulation within the melter offgas system as a result of low temperatures Isolate the ammonia flow at the ammonia/air-dilution skid when temperature drops below a predetermined setpoint.	Section 4.4.35, Appendix 4A-2 LAW PDSA
Caustic scrubber outlet high temperature interlocks Section **3.9.2.6.5**	Prevent high temperature offgas from impacting the safety function of the melter offgas exhausters. Isolate power to the catalytic oxidizer electric heater, isolate the ammonia supply to the SCO/SCR skid, and open the SCO/SCR skid bypass valve when temperature rises above a predetermined setpoint	Section 4.4.36, Appendix 4A-2 LAW PDSA

Equipment/Component Description	Credited Safety Function	Reference
Caustic scrubber bypass interlock Section **3.9.2.6.4**	Prevent a significant quantity of high temperature offgas from bypassing the caustic scrubber and impacting the safety function of the melter offgas exhausters. Isolate power to the catalytic oxidizer electric heater, isolate the ammonia supply to the SCO/SCR skid, and open the SCO/SCR bypass valve upon detection of the caustic scrubber bypass valve no longer being closed.	Section 4.4.37, Appendix 4A-2 LAW PDSA
Carbon bed adsorber water addition flow restriction device Section **3.7.2.2**	Limit the maximum water addition rate to the LAW carbon beds, to prevent the blockage of the melter offgas system due to excessive flooding of the carbon beds and subsequent filling of the connected offgas piping.	Section 4.4.38, Appendix 4A-2 LAW PDSA
Melter offgas exhauster shaft seal backup purge air and associated interlocks Section **3.9.2.8.1** Section **3.9.2.8.2** Section **3.9.2.8.3**	A backup bottled purge air supply is provided for each exhauster to maintain shaft seal confinement on loss of pressure from the normal plant air supply. Provide at least 2 hr of backup purge air to the LAW melter offgas exhausters Terminate melter feed to both exhausters at least 2 hr prior to loss of the backup purge air supply.	Section 4.4.43, Appendix 4A-2 LAW PDSA

Basis Discussion: All SSCs for the LOP and LVP offgas system, are credited SS for confinement, and as noted in the table. For more information on instruments, controls, and safety interlocks see sections 3.9.2 [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review design for correct safety designations and safety functions.	Document in EQPs

3.4.2.20 Seismic Design

Requirement: The LOP and LVP systems shall meet SC-III requirements. The piping and equipment shall provide a confinement boundary for melter offgas and an unobstructed flow path to the exhaust stack before, during and following an SC-III seismic event. The LVP system exhausters shall withstand an SC-III seismic event without losing function.

[Sections 4.4.1.3, 4.4.3.3, 4.4.3.4, 4.4.3.5, 4.4.5.3, 4.4.6.3, 4.4.7.3, 4.4.8.3, 4.4.9.3, 4.4.10.3, 4.4.11.3, 4.4.14.3, 4.4.22.3, 4.4.23.3, 4.4.24.3, 4.4.32.3, 4.4.33.3, 4.4.34.3, 4.4.35.3, 4.4.36.3, 4.4.37.3, 4.4.38.3, 4.4.43.3, Appendix 4A, 5.6.3, 5.6.19, PDSA – LAW Facility]

Table 3-3 LOP and LVP Seismic Equipment

Description	Seismic Category	Reference

Offgas System:
• Melter offgas system confinement boundary
  o Melter offgas system piping (including SBS standby line),
  o HEPA filter housing,
  o Offgas components (WESP, SBS, etc.),
  o Mercury mitigation exhaust path
  o Interfacing system components that form part of the confinement boundary (e.g., SDJ sampling interfaces)
• Melter offgas HEPA filter train isolation valves
• Melter offgas HEPA filter preheaters
  o Preheater LVP-HTR-00001A and -00003A confinement boundary
  o Preheater LVP-HTR-00001B and -00003B confinement boundary and internal heating elements
• Melter Offgas System exhausters
• Melter offgas exhauster check valves for backflow prevention, isolation dampers
• Non-manual isolation valves within the melter offgas system
• Isolation valves on the demineralized water supplies to bulge LOP-BULGE-00001, LOP-BULGE-00002, and the priming lines to LOP-PMP-00001, LOP-PMP-00002, LOP- PMP-00004, and LOP-PMP-00005
• SBS condensate purge pump shutdown components
• SBS water purge pump shutdown components
• WESP demineralized water flush valve
• Mercury mitigation skid bypass valve
• Mercury mitigation skid carbon adsorber isolation valves
• Carbon bed water addition line and flow restriction device
• Vessel vent header pressure control valve
• Catalytic oxidizer/reducer unit skid heater
• Ammonia supply isolation valve on the ammonia/air dilution skid
• Dilution air supply isolation valve on the ammonia/air dilution skid
• Catalytic oxidizer/reducer unit skid bypass valve
• Loop seal and drain line from the caustic scrubber to the caustic collection tank
• Caustic recirculation line isolation valve (including intervening piping between isolation valve and the caustic scrubber)
• Caustic scrubber process water line isolation valve (including intervening piping between isolation valve and the caustic scrubber)
• Caustic scrubber bypass valve
	SC-III	(PDSA – LAW Facility - Chapter 4, Sections 4.4.1, 4.4.2, 4.4.3, 4.4.5, 4.4.6, 4.4.7, 4.4.8, 4.4.9, 4.4.10, 4.4.11, 4.4.13, 4.4.19, 4.4.25, 4.4.27, 4.4.32, 4.4.33, 4.4.34, 4.4.35, 4.4.36, 4.4.37, 4.4.38)

Exhaust Stack • Melter offgas exhaust stack piping	SC-III	(NPH interaction effects, PDSA – LAW Facility - Chapter 4, Section 4.4.1)
Instrumentation and Controls • Safety instrumentation associated with active SC-III SSCs	SC-III	
• Valve actuated by interlock to open on high offgas temperatures at the film cooler outlet	SC-III	(PDSA – LAW Facility - Chapter 4, Section 4.4.24)
Anchorages • LOP-VSL-00001/2	SC-III / SC-IV	(NPH interaction effects)
Chilled Water System • Internal chilled water cooling coil in the SBS for confinement of chilled water • Dual PSVs connected to a 3-way valve (3 such arrangements, one on the line to the internal chilled water cooling coil, and one on each of the lines to SBS and SBS condensate vessel cooling jackets)	SC-III	(PDSA – LAW Facility - Chapter 4, Sections 4.4.3, 4.4.22)
Exhauster Shaft Seal - Backup Purge Air Supply • Piping and components from the backup purge air supply bottles to the exhauster shaft seals. Normal purge air supply piping from the Safety isolation valve to the exhauster shaft seals.	SC-III	(PDSA – LAW Facility - Chapter 4, Section 4.4.43)

Basis Discussion: The 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II (SRD), Safety Criterion 4.1 3 details the equivalence of the WTP seismic category to the seismic performance category of DOE STD 1020-94, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities. The SRD also states that SSCs designated as safety SSCs be designed to withstand the effects of NPH events (e.g., earthquakes, wind, and floods) without loss of capability to perform specified safety functions. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	**ENG**	Perform an analysis to verify the ability of the systems piping and equipment to withstand a SC-III seismic event to maintain confinement.	
R	**ENG**	Review design to verify alignment with analysis.	May be documented in assessment/evaluation report.

3.4.3 System Interface Requirements

Requirements associated with specific system interfaces are discussed in the subsequent requirement sections 3.X.3 titled "System Interface Requirements." The LOP and LVP system interfaces are listed in Table **3-4** and Table **3-5** below: (A.4, A.5.1, A.8.1, C.1, D.1, F.1.1)

Table 3-4 LOP Interfacing Systems

	System Name	
CHW	Chilled water	SBS cooling jackets and coils receive chilled water.
DIW	Demineralized water	Primary and standby offgas film coolers, SBSs, SBS condensate vessels, SBS condensate purge pumps, WESPs flush and misters, and valve bulges receive demineralized water.
ISA	Instrument service air	Valve actuators receive air.
LMP	LAW melter process	Primary and standby offgas film coolers receive melter offgas.
LVE	Low voltage electrical	SBS water purge pumps, SBS condensate purge pumps, WESPs, and solenoid valves receive low voltage power.
LVP	LAW secondary offgas/vessel vent process	WESPs supply primary offgas.
PCJ	Process control	Components without active safety instrumented functions receive control signals.
PPJ	Programmable protection	Components with active safety instrumented functions receive control signals.
PSA	Plant service air	Primary and standby offgas film coolers, and WESP purge air heaters receive plant service air.
RLD	Radioactive liquid waste disposal	SBS water purge pumps, SBS condensate purge pumps, and WESPs supply condensate. Valve bulges supply drains.
RWH	Radioactive solid waste handling	SBSs, SBS condensate vessels, and WESPs supply equipment for removal and packaging (maintenance only)

Table 3-5 LVP Interfacing Systems

System Locator	System Name	Nature of Interface
AMR	Ammonia reagent	Ammonia/air dilution skid receives ammonia.
C3V	C3 ventilation	Ammonia/air dilution skid receives C3 air.
DEP (EMF)	DFLAW effluent management facility	Vessel vent flush, caustic effluent and SBS condensate collection (DFLAW configuration).
DIW	Demineralized water	Vessel vent header receives flush water.
ISA	Instrument service air	Instrumentation and valve actuators receive air.
LCP	LAW concentrate receipt process	Vessel vent header receives vessel vents.
LFP	LAW melter feed process	Vessel vent header receives vessel vents.
LOP	LAW primary offgas process	HEPA filter preheaters receive primary offgas.
LVE	Low voltage electrical	Catalytic oxidizer electric heater, ammonia dilution fans, caustic scrubber recirculation pumps, caustic blowdown transfer pumps, and solenoid valves receive low voltage power.
PCJ	Process control	Components without active safety instrumented functions receive control signals.
PPJ	Programmable protection	Components with active safety instrumented functions receive control signals.

Table 3-5 LVP Interfacing Systems

System Locator	System Name	Nature of Interface
PSA	Plant service air	Off-gas treatment components receive plant service air (e.g. damper motive power). Normal exhauster shaft seal air.
PSW	Process service water	Mercury adsorbers, caustic scrubber, and caustic collection tank receive process water.
RLD	Radioactive liquid waste disposal	Vessel vent header receives vessel vents and supplies drains. Berm surrounding caustic collection tank supplies drains.
RWH	Radioactive solid waste handling	HEPA filters, mercury adsorbers, and catalytic oxidizer/reducer supply spent filter media, activated carbon media, VOC catalyst, and SCR catalyst for removal and packaging (maintenance only).
SDJ	Stack discharge monitoring	Monitors stack exhaust in conformance with permit requirements.
SHR	Sodium hydroxide reagent	Sodium hydroxide is added to the caustic blowdown transfer pump to neutralize the acid gases.
UPE	Uninterruptible power electrical	HEPA filter preheaters and exhausters receive uninterruptible power.

3.4.3.1 Stack Monitoring

Requirement: The LOP and LVP systems shall provide an interface with the stack monitoring (SDJ) system at the melter offgas, and vessel ventilation extracts from the facility. [Section 9.4.12, 9.4.12.2, BOD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review design to verify stack monitoring interfaces are provided for the melter offgas and vessel ventilation extracts from the facility.	

3.4.3.2 Stack Monitoring Design Standards

Requirement: The LOP and LVP systems' stack design shall interface with radiological stack monitoring systems in accordance with ANSI/HPS N13.1, 40 CFR 52, 40 CFR 61, and WAC 246-247. [Section 9.4.12.2, BOD]

Basis Discussion: [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	**ENG**	Review design to verify radiological stack monitoring systems provide for sample points that conform to the requirement.	

3.4.3.3 LVP Interfaces for Scrubber Effluent Disposal

Requirement: The LVP system shall interface with either the RLD system in the PT facility (baseline configuration) or the DEP system in the EMF (DFLAW configuration) for treatment/disposal of caustic scrubber effluents. (A.7.1)

Basis Discussion: Scrubber effluent collected by the caustic collection vessel is sent to either the RLD system in PT facility (baseline configuration) or the DEP system in the EMF (DFLAW configuration) for further treatment/disposal.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the LVP system interfaces with either the RLD system in the PT facility (baseline configuration) or the DEP system in the EMF (DFLAW configuration) for treatment/disposal of caustic scrubber effluents	

3.4.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.4.4.1 Removal of Offgas Mechanical Equipment

Requirement: The LOP and LVP systems' replaceable mechanical equipment shall provide the capability to be removable through removal routes into maintenance areas. [Section 11.3.2.3, BOD] (E.1)

Basis Discussion: Provisions should be made in the layout for adequate maintenance areas that allow access around the equipment for servicing, inspecting, and replacing equipment and components. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Perform inspection to verify the mechanical equipment is removable.	

3.4.4.2 Sampling Requirements during Commissioning

Requirement: The LOP and LVP systems shall provide access points for connecting or inserting temporary flow, pressure, and temperature measuring equipment for commissioning purposes, including additional manual sampling primarily from the offgas plant areas to accommodate the sampling requirements for environmental performance testing. [Section 19.8, 19.12, ORD]

Basis Discussion: Additional manual sampling accommodates the additional sampling requirements for environmental performance testing. The Design, Research and Technology, Commissioning, and Environmental organizations jointly identifies these requirements. The laboratory, or temporary laboratory, and associated infrastructure are to be available to support cold commissioning. The permanent Analytical Laboratory supports hot commissioning of the processing facilities.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Perform design review to verify ports are available to support the manual sampling required to accommodate environmental performance testing.	May be documented in assessment/evaluation report.

3.4.4.3 Vessel Entry

Requirement: The LOP and LVP vessels design shall provide a means of gaining personnel access to each vessel to facilitate vessel integrity inspection, cleaning, and draining of contents. The access design shall include provisions for a temporary cover for commissioning purposes, including a mechanism to securely lock the cover in place and providing a positive seal. The design shall also include provisions for a permanent cover (with appropriate shielding) to be fitted in place for normal operations. [Section 19.10, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify vessels are capable of providing a means of gaining personnel access to each vessel to facilitate vessel integrity inspection, cleaning, and draining of contents.	

3.4.4.4 Pipe and Vessel Flushing

Requirement: The LOP and LVP systems' pipelines and vessels carrying contaminated or potentially contaminated liquid shall be fully drainable and flushable for cleaning. Physical provision shall be made for cleaning and draining (to minimum heel volume) of hardware, vessels, and associated piping. [Section 20.0, ORD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to determine pipelines and vessels which carry or potentially carry contaminated liquid and verify they are fully drainable and flushable.	May be documented in assessment/evaluation report.

3.4.4.5 In-Line Flowmeter Bypasses

Requirement: The LOP and LVP systems' piping shall include bypasses for in-line mounted flowmeters where flow interruption is not acceptable. [Section 11.16, ORD]

Basis Discussion: This allows for continuous operation of the process, if flowmeter design does not permit routine maintenance without removal from service.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to determine where flow interruption is not acceptable and verify bypasses for in-line mounted flowmeters are included	May be documented in assessment/evaluation report.

3.4.4.6 Filtration Systems

Requirement: The LVP system shall provide standby filtration systems that allows filters to be changed offline. [Section 15.1, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify standby filtration systems are included and that they allow filters to be changed offline.	

3.4.4.7 Backflow Prevention – Support Utilities

Requirement: The LOP and LVP systems' utility system connections to contaminated process streams shall have engineered devices such as air gaps or adequate backflow preventers. [Section 7.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify engineered devices such as air gaps or adequate backflow preventers for utility system connections to the process.	

3.4.4.8 Isolation and Test Points

Requirement: The LOP and LVP systems' shall provide isolation and test points with drain/bleed valves to allow for removal, replacement, and testing during normal operations. [Section 9.1, 19.14, ORD] [Section 11.5.1, BOD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify isolation and test points with drain/bleed valves are provided for testing during normal operations.	

3.4.4.9 Utility Piping

Requirement: The LOP and LVP systems' process and utility piping shall have a means to prevent or mitigate cross-contamination [Section 7.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify process and utility piping have a means to prevent or mitigate cross-contamination	

3.4.4.10 Preventing Backflow

Requirement: The LOP and LVP systems shall be capable of preventing unplanned siphoning or backflow. [Section 7.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify features are included to prevent unplanned siphoning or backflow.	

3.4.4.11 Radioactive Isolation Provisions

Requirement: The LOP and LVP systems shall be provided with suitable isolation provisions to prevent diffusion, backflow, or other methods of leakage of the contents to areas where the material is not intended. [Section 5.1.2, BOD] [Section 15.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify suitable isolation provisions are provided to prevent diffusion, backflow, or other methods of leakage of the contents to areas where the material is not intended.	

3.4.4.12 Isolation Dampers and Valves

Requirement: The LOP and LVP systems' isolation dampers/valves shall be installed upstream and downstream of the filter banks to facilitate filter changing. [Section 15.1, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify isolation dampers/valves inclusion and location.	

3.4.4.13 Radiological Safety Bulges

Requirement: The LOP and LVP systems shall provide an engineered method for removal of equipment from bulges, taking into consideration containment and radiation control. [Section 8.1.3, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the required engineered methods for removal of equipment from bulges are in place.	

3.4.4.14 Plant Safety

Requirement: The LOP and LVP systems requirements for manual lifting of more than 40 pounds (NIOSH lifting guide, 1991) of equipment or materials as a part of routine operation shall be evaluated, taking into consideration the number of times to be lifted, location, and how far load is to be carried. [Section 8.1.1, ORD]

Basis Discussion: The design requirement is to not select equipment or materials over 40 pounds for routine manual use.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review operations documentation to verify manual lifting requirements of more than 40 pounds (NIOSH lifting guide, 1991) of equipment or materials as a part of routine operation, taking into consideration the number of times to be lifted, location, how far load is to be carried.	

3.4.4.15 OSHA High Temperature

Requirement: The LOP and LVP systems shall provide insulation or protection per OSHA requirements for equipment which operates at high temperatures and in accessible areas where maintenance is required. [Section 15.1, ORD]

Basis Discussion: This applies to equipment greater than 140 degrees and in accessible areas (e.g. HEPA pre-heater, steam lines that serve LOP equipment, mercury mitigation skid). The insulation is to be sectionalized and removable on equipment for which maintenance access is needed.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify insulation or protection per OSHA requirements for equipment which operates at high temperatures and is in accessible areas.	

3.4.4.16 Pump Seals

Requirement: The LOP and LVP systems' pump seals upon failure, shall not provide a pathway for hazardous liquids or gases to personnel or to the environment. [Section 14.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify pump seals upon failure do not provide a pathway for liquids or gases to personnel or to the environment.	

3.4.4.17 Decontamination

Requirement: The LOP and LVP systems' equipment subject to decontamination shall be designed to withstand this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved. [Section 9.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to determine which equipment is subject to decontamination.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify equipment which is subject to decontamination is able to withstand this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved.	

3.4.4.18 Environmental Compliance

Requirement: The LOP and LVP systems shall provide sample points with safe access upstream and downstream of abatement ventilation equipment for environmental performance testing. [Section 8.2, ORD]

Basis Discussion: Environmental performance testing is required on the offgas abatement (mitigation) equipment during both commissioning and operations. Safe personnel access to these sample points is necessary to facilitate the collection of samples or the installation of temporary monitoring equipment.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform assessment to determine required sample points needed to support environmental performance testing, during both commissioning and operations.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify sample points needed to support environmental performance testing, during both commissioning and operations are available.	

3.4.4.19 Instrument Cable Length

Requirement: The LOP and LVP systems' valves and instruments shall have sufficient cable length so that the element can be withdrawn without disconnecting where termination is made to a measuring element that has to be withdrawn. Temperature elements installed in thermowells shall allow for removal without interrupting the process. [Section 11.16, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify valves and instruments have sufficient cable length so that the element can be withdrawn without disconnecting where termination is made to a measuring element that has to be withdrawn.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify temperature elements are installed in thermowells and allow for removal without interrupting the process.	

3.4.4.20 Instrument Protection

Requirement: The LOP and LVP systems' valves and instruments shall be protected from adverse environmental conditions such as excessive heat, corrosion, vibration, and mechanical damage. [Section 11.16, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify valves and instruments are protected from adverse environmental conditions such as excessive heat, corrosion, vibration, and mechanical damage.	May be documented in assessment/evaluation report.

3.4.4.21 Instrument Detector Location

Requirement: The LOP and LVP systems' instruments and detectors that require maintenance are located outside the C3 contamination areas. However, transducer panels housing liquid level systems and associated remote I/O, and pressure transducers, shall be located in C3 classified areas as a precaution against back-contamination. [Section 11.16, ORD]

Basis Discussion: Locating transducer panels housing liquid level systems in the C3 classified areas serves as a precaution against back-contamination. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform assessment to determine instruments and detectors that require maintenance	May be documented in assessment/evaluation report.
R	ENG	Review design to verify instruments and detectors that require maintenance are located outside the C3 contamination areas.	

3.4.4.22 Instrument Remote Calibration

Requirement: The LOP and LVP systems' instrumentation shall be capable of being tested and calibrated from outside of remotely installed locations such as bulges. [Section 11.6, ORD]

Basis Discussion: None [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify instrumentation is capable of being tested and calibrated from outside of remotely installed locations	

3.4.4.23 Instrument Clean-out Port

Requirement: The LOP and LVP systems' shall include a mechanical clean-out port capability available for unplugging pneumercator tubes. [Section 11.16, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify mechanical clean-out ports for unplugging pneumercator tubes are included.	

3.4.4.24 Instrument Calibrations

Requirement: The LOP and LVP systems shall be capable of performing instrument calibrations, preventive maintenance, routine calibrations, and periodic functional testing of protective circuits while the system is in normal operation. [Section 9.1, ORD]

Basis Discussion: The intent is to prevent shutdowns or reduction of operational capabilities in order to perform routine maintenance.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify systems are capable of performing instrument calibrations, preventive maintenance, and performance of routine calibrations, preventive maintenance and periodic functional testing of protective circuits while the plant is in normal operation.	

3.4.4.25 Inspection Provisions

Requirement: The LOP and LVP systems' plant and equipment that contains dangerous (hazardous) wastes shall have inspection provisions. [Section 14.13, ORD]

Basis Discussion: Inspection may be visual or by TV system to allow for observation of any indication of leaks.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify equipment which contains dangerous wastes is capable of being inspected by visual or TV.	

3.5 Submerged Bed Scrubber – Primary Offgas Treatment System Requirements

3.5.1 Mission and Functional / Performance Requirements (Including States and Modes)

Not used.

3.5.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.5.2.1 Confine Scrubbing Liquid

Requirement: The LOP system SBS vessels shall remain intact and confine scrubbing liquid to ensure adequate liquid level for offgas system operation. [Sections 4.4.3.3, PDSA - LAW Facility]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine adequate liquid level for offgas system operation.	
R	ENG	Review design to verify the system is capable of remaining intact and maintaining proper liquid level for offgas operation, in per analyses.	May be documented in assessment/evaluation report.

3.5.2.2 Submerged Bed Scrubber Internal Cooling Coils

Requirement: The SBS internal cooling coils shall be designed to remain intact and reliably confine chilled water to minimize the potential for leaks which could flood the SBS vessels with chilled water. [Sections 4.4.3.4, 4.4.3.5, PDSA - LAW Facility]

Basis Discussion: The cooling coil design is relied on to prevent coil failure that could flood the SBS vessel with chilled water and cause a blockage in offgas flow. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify chilled water cooling coils are designed per applicable codes and standards.	May be documented in assessment/evaluation report.

3.5.2.3 SBS and SBS Condensate Cooling Pressure Relief

Requirement: The SBS and SBS condensate chilled water cooling coil design shall include overpressure protection. [Sections 4.4.22.1, PDSA - LAW Facility]

Basis Discussion: Overpressure protection prevents flooding of the SBS and SBS condensate vessel due to in-leakage from chilled water flow when the chilled water flow is re-established. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design of the melter offgas system to verify the SBS and SBS condensate chilled water cooling coils include overpressure protection.	

3.5.2.4 Alternate path to the SBS

Requirement: The melter offgas design shall include an alternate path to the SBS. [Sections 4.4.3.3, PDSA - LAW Facility]

Basis Discussion: Provides a bypass of the film cooler if needed.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design of the melter offgas system to verify there is an alternate path to the SBS (e.g. film cooler bypass).	

3.5.3 System Interface Requirements

Not used.

3.5.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.5.4.1 Anti-Siphon Holes in the Recycle Lines

Requirement: The LOP system SBS shall provide anti-siphon holes in the recycle lines from the SBS condensate purge pumps to the SBS. [Sections 4.4.5.5, 5.6.17, PDSA – LAW Facility]

Basis Discussion: This prevents siphoning from the SBS below the low-level trip setpoint of the SBS level instrumentation and associated interlock.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the design to verify SBS anti-siphon holes in the recycle lines.	

3.5.4.2 Demineralized Water Supply Isolation

Requirement: The demineralized water supply piping to the SBS and SBS Condensate Vessel spray nozzles and wands shall have blind flanges to prevent introduction of flush water during melter operation. [Sections 4.4.3.3, 4.4.3.5 PDSA - LAW Facility]

Basis Discussion: Blind flanges are utilized to isolate the SBS and SBS Condensate vessel from the demineralized water supply to prevent inadvertent flush water addition to the SBS and SBS condensate vessels while the melters are operating. Blind flange removal is only intended for decontamination or flushing activities. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design of the SBS and SBS Condensate Vessel to verify the inclusion of blind flanges to prevent inadvertent flush water addition to the SBS and SBS Condensate Vessels during melter operation.	

3.6 High Efficiency Particulate Air Filters Treatment System Requirements

3.6.1 Mission and Functional / Performance Requirements (Including States and Modes)

Not Used.

3.6.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.6.2.1 HEPA Preheaters Performance

Requirement: The LVP system HEPA preheaters shall provide the capability to keep the flow stream temperatures high enough to prevent condensation, and shall be capable of producing a minimum temperature increase of 10 °C that will provide the necessary temperature differential to prevent blinding of the HEPA filters. [Section 4.4.32.5, PDSA - LAW Facility]

Basis Discussion: The heater elements on the melter offgas HEPA preheaters (including control systems and power source) are considered SS to keep the flow stream temperatures high enough to prevent condensation and blinding of the HEPA filters, which could restrict the melter offgas system flow path and result in a melter offgas release event. Blinding of the HEPA filters is a gradual process such that, with the setpoint selected for safety control intervention, the periodic sampling and actuation of successive safety heating elements does not represent a melter offgas system HEPA filter blockage concern. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the HEPA preheaters are capable of preventing condensation, and producing a minimum temperature increase of 10 °C.	May be documented in assessment/evaluation report.
R	ENG	Review design for conformance with analysis.	
T	SU/ COM	Test to verify HEPA preheaters are capable of producing a minimum temperature increase of 10 °C.	

3.6.2.2 Melter Offgas Piping

Requirement: The LVP system shall ensure the HEPA filters are at a higher elevation than the WESP to prevent flooding of the HEPA filters from liquids generated in the WESP [Sections 4.4.3.1, 4.4.3.3, Appendix 4A, 5.6.3, PDSA - LAW Facility]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the elevation difference between the WESP and HEPA filters will prevent flooding the HEPA filters.	

3.6.3 System Interface Requirements

Not used.

3.6.4 Other Technical, Specialty, Operations, and Maintenance Requirements

3.6.4.1 Isolation Dampers

Requirement: The LVP system isolation dampers shall be provided on fans and filter banks. [Section 15.1, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify isolation dampers are provided on fans and filter banks.	

3.7 Mercury Mitigation Skid – Secondary Offgas Treatment System Requirements

3.7.1 Mission and Functional / Performance Requirements (Including States and Modes)

Not used.

3.7.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.7.2.1 Mercury Mitigation Skid Action Time to Detect a Fire and Close the Isolation Valves

Requirement: The LVP system mercury mitigation skid shall be capable of a maximum allowable time of 170 seconds to detect a fire and close the isolation valves, as determined in Appendix A of 24590-LAW-Z0C-20-00002, *Design Basis Event - Law Fire Analysis* [Sections 3.4.1.3.6, 4.4.3.1, 5.5.8, PDSA - LAW Facility] (I.2.16)(I.2.12) (I.2.13)

Basis Discussion: The inlet and outlet valves to each carbon bed adsorber are required to be closed on detection of high differential CO or CO_2 concentrations across the mercury mitigation skid. The differential concentration setpoints for the CO and CO_2 monitors set at values that ensure the fire is detected, and the carbon adsorber isolation valves are closed within sufficient time after initiation of a design basis fire such that 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II* (SRD) Safety Criterion 2.0-2 consequence criteria are not challenged.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify the mercury mitigation skid is capable of meeting the maximum allowable action time to detect a fire and close isolation valves.	May be documented in assessment/evaluation report.

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the mercury mitigation skid is capable of detecting a fire and closing the isolation valves within a maximum allowable time of 170 seconds.	
T	SU/ COM	Test to verify mercury mitigation skid is capable of detecting high CO or CO_2 concentrations (indicating a fire) and closing the isolation valves within a maximum allowable time of 170 seconds.	System design requires detection of high differential CO or CO_2 concentrations.

3.7.2.2 Mercury Mitigation Skid Carbon Bed Adsorber Water Flow Restriction

Requirement: The LVP system mercury mitigation skid activated carbon adsorber water flow restriction device water addition line shall restrict flow to the carbon beds such that blockage of the melter offgas system will not occur in less than two hours. [Sections 4.4.38.2, 4.4.38.3, 4.5.1.4, 5.6.3, PDSA - LAW Facility]

Basis Discussion: The water restriction device ensures that even if water additions begin immediately following carbon bed isolation due to a fire, blockage of the melter offgas system does not occur before any existing cold caps on the melters are burned off.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine maximum flow rate for water addition.	
R	ENG	Review design to verify the carbon adsorber water flow restriction device can restrict flow per analysis.	

3.7.2.3 Carbon Adsorber Oxygen Limit

Requirement: The total inflow of oxygen to the isolated carbon adsorbers shall be no greater than 152 lbs/hr of melter offgas. The total oxygen inflow limit shall account for both leakage through the isolation valves and backflow of oxygen (due to countercurrent flow or diffusion) via the pressure relief path from each carbon adsorber. [Sections 3.4.1.3.6, 4.4.3.3, PDSA - LAW Facility]

Basis Discussion: The configuration of the exhaust path from the carbon adsorbers ensures oxygen backflow into the carbon adsorbers is limited. The in-leakage limit from all sources controls the flow of oxygen to a fire.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify total inflow of oxygen is no greater than 152 lbs/hr.	
R	ENG	Review design to verify conformance with the analysis for total inflow of oxygen.	
T	SU/ COM	Test to verify in-leakage to the isolated carbon adsorbers is less than 152 lbs/hr.	May be performed as part of supplier acceptance tests

3.7.2.4 Carbon Adsorber Temperature

Requirement: The carbon adsorber vessels and downstream melter offgas components shall be designed to withstand elevated temperatures associated with the carbon bed fire. [Sections 4.4.3.3, PDSA - LAW Facility]

Basis Discussion: The melter offgas system confinement boundary should remain intact during a carbon bed fire. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an assessment to determine the maximum temperature the offgas components are required to withstand.	
R	ENG	Review design of the melter offgas system to verify the carbon adsorber vessels and downstream SSCs maintain containment during elevated temperatures associated with a carbon bed fire per the analysis.	

3.7.3 System Interface Requirements

Not used.

3.7.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.7.4.1 Access to the Mercury Mitigation Skid Instrumentation and Interlocks

Requirement: The LVP system mercury mitigation skid activated carbon adsorber shall provide the capability for periodic calibration of the CO_x monitors, offgas temperature monitor, pressure monitors, and liquid level detectors to ensure accurate activation of the isolation and bypass valve interlocks. [Section 4.4.11.6, 5.5.8, PDSA - LAW Facility]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify carbon adsorbers provide the ability for calibration.	

3.7.4.2 Mercury Mitigation Skid Pressure Relief Path

Requirement: The LVP system mercury mitigation skid carbon adsorbers shall provide the capability to establish an alternate vent path to prevent vessel over-pressurization, and to confine hazardous constituents to protect the facility worker. [Sections 4.4.3.5, PDSA - LAW Facility]

Basis Discussion: The pressure relief path from each of the adsorbers ties into the melter offgas piping downstream of the adsorbers but upstream of the manual isolation valve used to isolate the skid for maintenance activities. During normal operations, the manual isolation valve is locked open consistent with administrative controls established to maintain an open pathway to the exhaust stack. During maintenance activities that require

closure of the skid outlet valve, an alternate vent path is established to prevent vessel over-pressurization and to confine hazardous constituents to protect the facility worker. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify mercury adsorbers provide the ability to establish an alternate vent path.	

3.8 Exhauster Fans - Secondary Offgas Treatment System Requirements

3.8.1 Mission and Functional / Performance Requirements (Including States and Modes)

3.8.1.1 Fan auto-changeover

Requirement: The LVP system shall provide a fan auto-changer capability which detects the failure of an operational fan and automatically starts the standby unit when required. [Section 15.1, ORD]

Basis Discussion: The melter offgas system uses three exhausters, with two normally running via ICN control and the third in standby to increase the reliability of the SS safety function to provide adequate melter venting. The fan auto-changeover engages the standby fan as necessary.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the fan auto-changer capability which detects the failure of an operational fan and automatically starts the standby unit when required.	

3.8.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.8.2.1 Exhauster Fans – Normal Operation

Requirement: Two melter exhauster fans shall provide sufficient motive force to pull offgas from the melter plena through downstream components and direct it through the exhaust stack. [Section 3.4.1.2.1, Appendix 4A Table 4A-2, PDSA - LAW Facility]

Basis Discussion: The melter offgas system uses three exhausters, with two normally running via ICN control and the third in standby to increase the reliability of the SS safety function to provide adequate melter venting. The two operating exhausters are sufficiently sized to maintain adequate depression on the melters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine minimum motive force required to pull offgas from the melter plena through downstream components.	
R	ENG	Review design to verify minimum motive force required to pull offgas from the melter plena through downstream components is provided, per analysis.	

3.8.2.2 Exhauster Fans – Loss of Normal Power

Requirement: The LVP system exhauster fans shall ensure that during loss of normal facility power or insufficient vacuum in the LVP system header, two exhausters operating at a (reduced) fixed speed provide sufficient motive force to pull offgas from the melter plena through downstream components. [Sections 4.4.3.3, 4.4.3.5, PDSA - LAW Facility]

Basis Discussion: The melter offgas system uses three exhausters, with two normally running via ICN control and the third in standby to increase the reliability of the SS safety function to provide adequate melter venting. Upon detection of a loss of normal facility power or insufficient vacuum in the LVP system header, the safety exhauster ASD controls are activated via the Safety PPJ system. Once initiated, each exhauster enters a fixed speed. In conjunction with other SS system reconfigurations to establish a known LOP/LVP system configuration, at least two exhausters at this fixed speed maintains adequate depression on the melters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine minimum motive force required to pull offgas from the melter plena through downstream components.	
R	ENG	Review design to verify minimum motive force required to pull offgas from the melter plena through downstream components is provided by two operating exhausters, per analysis.	

3.8.2.3 Exhauster Fans – Abnormal Operating Conditions

Requirement: The LVP system exhauster fans shall ensure that during abnormal operating conditions a single operating exhauster on normal ICN control, in conjunction with other SS system reconfigurations, can provide sufficient motive force to pull offgas from the melter plena through downstream components. [Sections 4.4.3.3, 4.4.3.5, PDSA - LAW Facility]

Basis Discussion: The melter offgas system uses three exhausters, with two normally running via ICN control and the third in standby to increase the reliability of the SS safety function to provide adequate melter venting. In abnormal operating conditions (when only one exhauster is available), the single operating exhausters is sufficiently sized to maintain adequate depression on the melters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify a single exhauster (in conjunction with other system configurations) fan provides adequate depression in the melter plena to offgas through the exhaust stack.	
R	ENG	Review design to verify minimum motive force required to pull offgas from the melter plena through downstream components is provided by a single operating exhauster, per analysis.	
T	SU/ COM	Test to verify minimum motive force required to pull offgas from the melter plena through downstream components is provided by a single operating exhauster.	

3.8.2.4 Uninterruptible Power Supply for Exhaust Fans

Requirement: The LVP system exhauster fans shall be supplied by uninterruptible power supply so that flow is maintained if normal power is lost. [Sections 4.4.10.1, 4.4.10.5, Appendix 4A, 5.5.1, 5.5.7, PDSA - LAW Facility]

Basis Discussion: Each UPS is sized for a two-hour battery capacity. UPS battery backed power is used during DBE to ensure the melter plenum is exhausted while all interlocks take place. The UPS requirements are included in the associated SDD.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the ability of the exhauster fans to run on uninterruptible power supply.	

3.8.2.5 Offgas Exhauster Backflow Prevention

Requirement: The melter offgas exhauster check valves for backflow prevention shall be installed so that recirculation loops do not negate the function of the exhausters, to protect the melter offgas system's ability to provide an elevated release of melter offgas. [Sections 4.4.3.1, 4.4.3.3, Appendix 4A, PDSA - LAW Facility]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify exhauster check valves configuration does not negate the exhauster function.	

3.8.3 System Interface Requirements

Not used.

3.8.4 Other Technical, Specialty, Operations and Maintenance Requirements

Not used.

3.9 Monitoring and Control Requirements

3.9.1 Mission and Functional / Performance Requirements (Including States and Modes)

3.9.1.1 Control and Instrumentation Reaction Times

Requirement: The LOP and LVP systems' control and instrumentation systems shall provide for automated responses without relying on operator manual action for at least 30 minutes after the onset of a credible failure event. [Section 11.10, ORD]

Basis Discussion: 30 minute criteria allows time for operator detection and response.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform and analysis to determine when automated response would be required within 30 minutes	
R	ENG	Review design to verify the ability of the system to provide an automated response within 30 minutes.	

3.9.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.9.2.1 General Safety

3.9.2.1.1 Active Safety Instruments – Programmable Protection System

Requirement: The LOP and LVP systems' instruments with active safety functions are required to interface with the PPJ or be engineered as local safety instrumented functions. Signal interfaces shall use standard 4-20 mA or digital contacts. [Section 7.1, BOD] [Section 15.1, ORD]

Basis Discussion: Appendix C provides a list of the LOP and LVP active safety instrumented functions and implementing components for the LOP and LVP system.

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review the system design to verify active safety-significant (SS) instrumented functions are controlled and monitored by the programmable protection system (PPJ)	

3.9.2.1.2 Implementation of Active Safety Instrumented Functions

Requirement: The active safety instrumented functions for the LOP and LVP systems shall be designed in accordance with the safety criterion 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II. [Safety Criterion, 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2, 4.3-4, SRD]

Basis Discussion: The SRD establishes the criterion and applicable standards for the safety design. The design processes including 24590-WTP-GPG-J-015, *Safety Instrumented System Implementation* and electrical design criteria are used to ensure independence and that the design complies with the mandated standards. The completed designs are documented in Safety Systems Requirements Specification and other design documents, which are required to be verified to ensure compliance with the standards.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Verify the Safety Systems Requirements Specifications and designs are in accordance with the criterion and standards in safety criterion 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II.	May be documented in assessment/evaluation report.

3.9.2.2 LOP Melter Train Interlocks

The melter train interlocks are duplicated in each melter train. Melter train one contains the same interlocks as melter train two.

3.9.2.2.1 Film Coolers High Outlet Temperature

Requirement: A temperature monitor on the film cooler outlet shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**) in the film cooler outlet, the valve on the in-bleed assembly that feeds the film cooler shall actuate open. [Sections 4.4.24.3, 5.5.18, Appendix 4A, PDSA - LAW Facility] (F.2.1)

Basis Discussion: To prevent excessive temperatures that could result in a breach of the melter offgas confinement boundary, the film cooler high temperature interlock opens the valve on the in-bleed assembly that feeds the film cooler, allowing air to feed the film cooler and cool the offgas from the melter.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the high outlet temperature that could result in a breach of the melter offgas confinement boundary	May be documented in assessment/evaluation report.
R	ENG	Perform design review to verify the interlock opens the valve on the in-bleed assembly upon detection of high temperature in the film cooler outlet.	
T	SU/ COM	Test to verify interlock opens the valve on the in-bleed assembly upon detection of high temperature in the film cooler outlet.	Perform as part of the integrated system test with PPJ

3.9.2.2.2 Wet Electrostatic Precipitator (WESP) High Liquid Level

Requirement: WESP level instrumentation shall be provided to detect an accumulation of liquid in the WESP. Upon detection of high liquid level (setpoint **TBD**), the WESP demineralized water flush valve shall close. [Sections 4.4.6.1, 4.4.6.3, 4.4.6.5, Appendix 4A, 5.5.3, PDSA - LAW Facility] (F.2.2)

Basis Discussion: The WESP demineralized water flush valve closes to shut off demineralized flush water to the WESP in order to prevent WESP flooding that can restrict flow of the offgas melter line, resulting in a melter offgas release event.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify interlock closes the demineralized water flush valve upon detection of WESP high liquid level.	
T	SU/ COM	Test to verify the interlock closes the demineralized water flush valve upon detection of WESP high liquid level.	Perform as part of the integrated system test with PPJ

3.9.2.2.3 SBS High Liquid Level

Requirement: SBS level instrumentation shall be provided to detect high liquid levels in the SBS vessel. Upon detection of a high liquid level in the SBS vessels, the following actions shall occur:

- Shut down the operating SBS condensate purge pump
- Close the isolation valves on the demineralized water connections to the bulges and priming lines associated with the SBS and SBS condensate vessels of concern.
- Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.

[Sections 4.4.5.3, Appendix 4A, 5.5.2, PDSA - LAW Facility] (F.2.3)

Basis Discussion: This safety function prevents liquid levels in the SBS that could result in a melter offgas release, as follows:

- Reduces the potential for the SBS condensate purge pumps to flood the SBS to the point of blocking the melter offgas pathway, which could result in a melter offgas release.
- Reduces the potential for demineralized water to flood the SBS (via the purge lines) to a level that could result in a blockage of the melter offgas.
- Protects against continued level increases in the SBS as a result of condensing water vapor from the melter feed.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interlock shuts down the SBS condensate purge pump, closes the demineralized water isolation valves the bulges and priming lines, and	

Verif. Method	Verif. By	Plan	Notes/Comments
		terminates feed to the melter, upon detection of a high liquid level in the SBS vessels.	
T	SU/ COM	Test to verify the interlock shuts down the SBS condensate purge pump, closes the demineralized water isolation valves the bulges and priming lines, and terminates feed to the melter, upon detection of a high liquid level in the SBS vessels.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.2.4 SBS Low Liquid Level

Requirement: SBS level instrumentation shall be provided to detect low liquid levels in the SBS vessel. Upon detection of a low liquid level in the SBS vessels, the following actions shall occur:

- Shut down the operating SBS water purge pump
- Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.

[Sections 3.4.1.1.1.6, 4.4.5.1, 4.4.5.3, 4.4.5.5, Appendix 4A, 5.5.2, PDSA - LAW Facility] (F.2.4)

Basis Discussion: The SBS vessels are designed to confine scrubbing liquid and to prevent in-leakage of chilled water from the external cooling jacket. Proper liquid level in the vessel is relied on to ensure adequate cooling of offgas and to ensure proper offgas flow balance from the two melters. Cooling provided by the SBS liquid is relied on to ensure offgas remains below the rated design temperature of downstream components. Should the liquid drain from the SBS, hot offgas could cause failure of downstream offgas system seals. Because the exhausters provide a draw on both SBS vessels simultaneously, a low liquid level condition in one SBS could induce preferential flow through that SBS and upset flow from the opposite train melter, causing stagnation of the melter and a potential release of offgas into the melter annulus.

This safety function provides the following:

- Shuts down the SBS water purge pump before SBS level drops too low. This reduces the potential for the SBS liquid level to be pumped down below the minimum necessary for the SBS to function without causing a preferential flow from one melter.
- Stops feed to the melter to ensure NO_x production is halted in the melters. Should liquid level continue to drop in the affected SBS over time due to evaporation, the NO_x hazard from the melter is eliminated before overheat damage to the offgas system can occur.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interlock shuts down the SBS water purge pump, and terminate feed to the melter, upon detection of a low liquid level in the SBS vessels.	
T	SU/ COM	Test to verify the interlock shuts down the SBS water purge pump, and terminate feed to the melter, upon detection of a low liquid level in the SBS vessels.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.3 LVP HEPA Interlocks

3.9.2.3.1 HEPA Preheaters High Outlet Temperature Interlocks

Requirement: Temperature instrumentation downstream of the preheaters shall be provided to detect an increase in temperatures in the offgas stream. Upon detection of high offgas temperatures (setpoint **TBD**) downstream of the preheaters, the following actions shall occur:

- Isolate power to the non-safety heating elements
- De-energize the Safety heating elements on each of the Safety preheaters

[Sections 4.4.32.3, 5.5.26, PDSA - LAW Facility] (F.2.5)

Basis Discussion: To prevent excessive temperatures that could result in a breach of the melter offgas confinement boundary, the preheater temperature interlocks turn off power to the heating elements.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the high outlet temperature that could result in a breach of the melter offgas confinement boundary	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock isolates the non-safety and safety heating elements, upon detection of a high outlet temperature in the offgas stream.	
T	SU/ COM	Test to verify the interlock isolates the non-safety and safety heating elements, upon detection of a high outlet temperature in the offgas stream.	Perform as part of the integrated system test with PPJ

3.9.2.3.2 HEPA Preheater Differential Temperature Interlocks

Requirement: Temperature instrumentation upstream and downstream of the preheaters shall be able to detect differential temperatures in the offgas stream. Upon detection of low differential temperatures (setpoint TBD), the following actions shall occur:

- Isolate power to the non-safety heating elements
- Energize the safety heating elements on each of the safety preheaters.
- Monitors offgas differential temperature, and energizes additional safety heating elements, as necessary, to achieve a minimum differential temperature.

[Section 4.4.32.1, PDSA – LAW Facility] (F.2.6)

Basis Discussion: The offgas piping splits into two trains, passes through the preheaters, and then rejoins into a single downstream line. Each train contains two preheater units. The first unit on each train contains a non-safety heating element that operates under normal control. The second unit on each train contains Safety heating elements that are energized as needed to ensure a minimum differential temperature is maintained.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the minimum differential temperature level.	May be documented in assessment/evaluation report.

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interlock isolates the non-safety and energizes the safety heating elements, upon detection of a high outlet temperature in the offgas stream.	
T	SU/ COM	Test to verify the interlock isolates the non-safety and energizes the safety heating elements, upon detection of a high outlet temperature in the offgas stream.	Perform as part of the integrated system test with PPJ

3.9.2.3.3 HEPA High Differential Pressure Interlock

Requirement: HEPA filter differential pressure instrumentation shall be provided to detect differential pressure changes in the offgas stream. Upon detection of high differential pressure (setpoint **TBD**), the system shall terminate feed to both melters (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps. [Sections 4.4.3.1, Appendix 4A, 5.5.1, PDSA - LAW Facility] (F.2.7)

Basis Discussion: The offgas HEPA filters differential pressure interlocks stop feed to both melters when high differential pressure is detected. The safety function reduces the likelihood of HEPA filter blockage to a degree that would prevent the flow of melter offgas to the exhaust stack.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum differential pressure.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock terminates feed to both melters upon detection of a high differential pressure in the offgas stream.	
T	SU/ COM	Test to verify the interlock terminates feed to both melters upon detection of a high differential pressure in the offgas stream.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.3.4 HEPA Isolation Valves Interlock

Requirement: The melter offgas HEPA filter isolation valve design shall ensure that the filter isolation valves cannot isolate both filter trains at the same time. The other non-manual isolation valves shall fail in "open" position if control signal or motive power is lost. [Sections 4.4.3.1, 4.4.3.3, Appendix 4A, 5.5.1, PDSA - LAW Facility] (F.2.8)

Basis Discussion: The melter offgas HEPA filter isolation valves are interlocked to ensure that both trains of HEPA filters cannot be isolated simultaneously. If both trains were isolated, the melter offgas system would be blocked. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify HEPA filter isolation valve interlocks prevent simultaneous isolation of both HEPA filter trains, and that non-manual isolation valves fail in "open" position if control signal or motive power is lost.	
T	SU/ COM	Test to verify HEPA filter isolation value interlocks prevent simultaneous isolation of both filter trains, and that non-manual isolation valves fail in "open" position if control signal or motive power is lost.	

3.9.2.4 Mercury Mitigation Skid Interlocks

3.9.2.4.1 Mercury Mitigation Skid High Differential Pressure Interlock

Requirement: Mercury mitigation skid pressure monitors shall be provided to detect high differential pressure across the skid indicative of a plugged carbon adsorber or closure of a carbon adsorber isolation valve. Upon detection of high differential pressure (setpoint TBD) across the skid, the mercury mitigation skid bypass valve shall be actuated open. [Sections 4.4.11.1, 4.4.3.1, 4.4.11.5, Appendix 4A, 5.5.8, PDSA - LAW Facility] (F.2.9)

Basis Discussion: The mercury mitigation skid bypass is relied on to redirect offgas flow around the skid whenever flow within the skid is obstructed. Pressure differential across the mercury mitigation skid is monitored to detect a blockage in offgas flow. On detection of high differential pressure the system opens the bypass valve, which redirects melter offgas flow around the mercury mitigation skid.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum differential pressure for the offgas entering the carbon absorbers.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock opens the bypass valve upon detection of a high differential pressure.	
T	SU/ COM	Test to verify the interlock opens the bypass valve upon detection of a high differential pressure.	Perform as part of the integrated system test with PPJ

3.9.2.4.2 Mercury Mitigation Skid High Inlet Temperature Interlock

Requirement: Temperature monitoring on the offgas inlet to the mercury mitigation skid shall be provided to detect hot offgas flow that may be capable of causing bulk ignition and burning of the carbon media. Upon detection of high offgas temperature (setpoint **TBD**), the following actions shall occur:

- Open the mercury mitigation skid bypass valve
- Close the offgas inlet valve to both carbon adsorbers.

[Section 4.4.3.1, PDSA – LAW Facility] (F.2.10)

Basis Discussion: These controls ensure that offgas flow through the carbon media does not approach the ignition temperature of the carbon media.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the upper temperature limit to prevent ignition of the carbon media	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock opens the mercury mitigation skid bypass valve, and closes the offgas inlet valve to both carbon adsorbers upon detection of a high temperature in the offgas inlet to the mercury mitigation skid.	
T	SU/ COM	Test to verify the interlock opens the mercury mitigation skid bypass valve, and closes the offgas inlet valve to both carbon adsorbers upon detection of a high temperature in the offgas inlet to the mercury mitigation skid.	Perform as part of the integrated system test with PPJ

3.9.2.4.3 Mercury Mitigation Skid High Differential CO_x Interlock

Requirement: Carbon oxides (CO_x) concentration monitors shall be provided across the mercury mitigation skid to detect an increase in CO or CO_2 concentration in the offgas stream, indicative of a carbon bed fire. Upon detection of high differential CO or CO_2 concentration (setpoint **TBD**), the following actions shall occur:

- Open the mercury mitigation skid bypass valve
- Close the offgas inlet and outlet valves of both carbon adsorbers
- Terminate feed to the operating melter (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps.

[Sections 4.4.11.1, 4.4.11.5, 5.5.8, PDSA - LAW Facility] (F.2.11)

Basis Discussion: The CO_x monitors and isolation valve interlock are required to detect a carbon bed fire and close the carbon adsorber isolation valves within the time frame determined in the accident analysis. The bypass valve interlock is necessary to ensure melter offgas flow is not obstructed when the carbon adsorber isolation valves are closed.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the CO_x level that is indicative of a carbon bed fire.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock opens the bypass valve, closes offgas inlet and outlet valves of both carbon adsorbers, and terminates feed to the melters, upon detection of high differential CO or CO_2 concentration.	
T	SU/ COM	Test to verify the interlock opens the bypass valve, closes offgas inlet and outlet valves of both carbon adsorbers, and terminates feed to the melters, upon detection of high differential CO or CO_2 concentration.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.5 Catalytic Oxidizer/Reducer Interlocks

3.9.2.5.1 SCO/SCR Skid High Differential Pressure Interlock

Requirement: SCO/SCR skid differential pressure detection instrumentation shall be provided to monitor differential pressures across the skid. Upon detection of a high differential pressure (setpoint **TBD**) across the skid, the SCR/SCO skid bypass valve shall be actuated open. [Sections 4.4.7.3, 5.5.4, PDSA - LAW Facility] (F.2.12)

Basis Discussion: Opening the catalytic oxidizer/reducer skid bypass valve maintains the offgas system flow capability if the differential pressure across the skid increases. This ensures the melter offgas system flowpath is maintained if a component on the catalytic oxidizer/reducer skid begins to be plugged, thereby preventing a subsequent melter offgas pressurization and release.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the high differential pressure indicative of SCO/SCR plugging.	May be documented in assessment/evaluation report.
R	ENG	Perform design review to verify the interlock opens the bypass valve upon detection of high differential pressure across the skid.	
T	SU/ COM	Test to verify the interlock opens the bypass valve upon detection of high differential pressure across the skid.	

3.9.2.5.2 SCO/SCR Skid High Electric Heater Temperature Interlock

Requirement: A temperature monitor downstream of the catalytic oxidizer/reducer skid heater shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**), power to the catalytic oxidizer/reducer skid heater shall be isolated. [Sections 4.4.14.1, 4.4.14.3, 5.5.10, PDSA - LAW Facility] (F.2.13)

Basis Discussion: The catalytic oxidizer/reducer skid heater interlock prevents excessive temperatures that could result in a breach of the melter offgas confinement boundary and a subsequent melter offgas release event.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the high temperature limit to prevent a breach of the melter offgas confinement boundary.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock isolates power to the skid heaters upon detection of high temperature.	
T	SU/ COM	Test to verify the interlock isolates power to the skid heaters upon detection of high temperature.	Perform as part of the integrated system test with PPJ

3.9.2.5.3 SCO/SCR Skid High Outlet Temperature Interlock

Requirement: A temperature monitor on the selective catalytic oxidizer/reducer skid outlet shall be provided to detect high temperatures that may be capable of failing the melter offgas confinement boundary. Upon detection of high temperature (setpoint **TBD**), the following actions shall occur:

- Isolate ammonia flow to the catalytic oxidizer/reducer skid
- Isolate the catalytic oxidizer/reducer skid heater

[Section 4.4.23.3, 5.5.17 PDSA – LAW Facility] (F.2.14)

Basis Discussion: The high outlet temperature interlock prevents excessive temperatures that could result in a breach of the melter offgas confinement boundary and a subsequent melter offgas release event.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the high outlet temperature limit to prevent a breach of the melter offgas confinement boundary.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock isolates ammonia flow and isolates the skid heaters, upon detection of high temperatures.	
T	SU/ COM	Test to verify the interlock isolates ammonia flow and isolates the skid heaters, upon detection of high temperatures.	

3.9.2.5.4 SCO/SCR Skid Low Outlet Temperature Interlock

Requirement: A temperature monitor on the selective catalytic oxidizer/reducer skid outlet shall be provided to detect low temperatures that could result in rapid ammonium nitrate formation. Upon detection of low temperature (setpoint **TBD**), the ammonia flow at the ammonia/air-dilution skid shall be isolated. [Sections 4.4.35.3, 5.5.29, PDSA - LAW Facility] (F.2.15)

Basis Discussion: Rapid formation of ammonium nitrate as a result of ammonia injection into the melter offgas system combined with low selective catalytic reducer skid temperatures can result in an ammonium nitrate accumulation rate that could block the melter offgas system.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the low outlet temperature limit to preclude formation of ammonium nitrate.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock isolates the ammonia flow to the skid, upon detection of low outlet temperature.	
T	SU/ COM	Test to verify the interlock isolates the ammonia flow to the skid, upon detection of low outlet temperature.	Perform as part of the integrated system test with PPJ

3.9.2.5.5 SCO/SCR Ammonia Supply High Flow Interlock

Requirement: Ammonia supply flow instrumentation shall be provided to detect a rise in ammonia supply flow. Upon detection of a high ammonia supply flow (setpoint **TBD**), the isolation valve on the ammonia supply line shall close. [Sections 4.4.16.1, 4.4.16.3, 5.5.12, PDSA - LAW Facility] (F.2.16)

Basis Discussion: The ammonia supply interlock prevents releases (from the exhaust stack, or backflow in to the facility) of NO_x or ammonia in excess of the chemical exposure standards, and prevents ammonia concentrations in the melter offgas system that could result in an ammonia fire or deflagration in the SCR unit.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the maximum allowable flow rate for the ammonia supply.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of high ammonia supply flow.	
T	SU/ COM	Test to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of high ammonia supply flow.	Perform as part of the integrated system test with PPJ

3.9.2.5.6 SCO/SCR Ammonia Supply Low/Reverse Dilution Air Flow Interlock

Requirement: Dilution-air flow instrumentation shall be provided to detect decreased/reverse dilution-air flow. Upon detection of decreased/reverse dilution-air flow (setpoint **TBD**), the isolation valve on the ammonia supply line shall close. [Sections 4.4.16.1, 4.4.16.3, 5.5.12, PDSA - LAW Facility] (F.2.17)

Basis Discussion: The ammonia supply interlocks prevents releases (from the exhaust stack, or backflow in to the facility) of NO_x or ammonia in excess of the chemical exposure standards, and prevent ammonia concentrations in the melter offgas system that could result in an ammonia fire or deflagration in the SCR unit.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the minimum allowable dilution-air flow rate.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of dilution-air flow below the minimum allowable.	
T	SU/ COM	Test to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of dilution-air flow below the minimum allowable.	Perform as part of the integrated system test with PPJ

3.9.2.5.7 SCO/SCR Ammonia Supply Isolation Valve

Requirement: The ammonia supply isolation valve shall fail closed upon a loss of control signal or loss of actuating power. [Sections 4.4.16.3, PDSA - LAW Facility]

Basis Discussion: The ammonia supply isolation valve prevents releases of ammonia in excess of the chemical exposure standards, from; a release of undiluted ammonia from the exhaust stack, backflow of ammonia through the dilution air supply system and subsequent release into the facility, and ammonia concentrations in the melter offgas system that could result in an ammonia fire or deflagration.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the ammonia supply isolation valve closes upon a loss of control signal or loss of actuating power.	
T	SU/ COM	Test to verify the ammonia supply isolation valve closes upon a loss of control signal or loss of actuating power.	Perform as part of the integrated system test with PPJ

3.9.2.6 Caustic Scrubber Interlocks

3.9.2.6.1 Caustic Scrubber High Differential Pressure Interlocks

Requirement: Caustic scrubber pressure detection instrumentation shall be provided to monitor differential pressures. Upon detection of high differential (setpoint **TBD**), the following actions shall occur:

- Close the caustic scrubber isolation valve on the recirculation line from the caustic collection tank
- Close the caustic scrubber spray water addition control valve
- Open the caustic scrubber bypass valve

[Sections 4.4.9.1, 4.4.9.3, 4.4.9.5, Appendix 4A, 5.5.6, PDSA - LAW Facility] (F.2.18)

Basis Discussion: Closing the recirculation and spray water valves stops water additions before levels rise too high, reducing the potential for flooding the caustic scrubber to the point of blocking the melter offgas pathway and resulting in a melter offgas release. Opening the bypass valve provides an unrestricted flowpath for the offgas.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Preform an analysis to determine the maximum allowable differential pressure across the caustic scrubber.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the recirculation and spray water valves, and opens the bypass valve upon detection of high differential pressure across the caustic scrubber.	
T	SU/ COM	Test to verify the interlock closes the recirculation and spray water valves, and opens the bypass valve upon detection of high differential pressure across the caustic scrubber.	Perform as part of the integrated system test with PPJ

3.9.2.6.2 Caustic Scrubber Recirculation Line Low Pressure Interlocks

Requirement: Recirculation line pressure detection instrumentation shall be provided to monitor caustic scrubber recirculation line pressure. Upon detection of low pressure (setpoint **TBD**) in the recirculation line the recirculation line isolation valve shall be closed. [Sections 4.4.9.1, 4.4.9.3, 4.4.9.5, Appendix 4A, 5.5.6, PDSA - LAW Facility] (F.2.19)

Basis Discussion: Closing the recirculation line isolation valve prevents a loss of melter depression due to excessive leakage into the melter offgas system as a result of a failed recirculation line.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the minimum allowable pressure for the caustic scrubber recirculation line.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the recirculation line isolation valve upon detection of low pressure in the recirculation line.	
T	SU/ COM	Test to verify the interlock closes the recirculation line isolation valve upon detection of low pressure in the recirculation line.	Perform as part of the integrated system test with PPJ

3.9.2.6.3 Caustic Scrubber Recirculation Line Low Flow Interlocks

Requirement: Recirculation line flow detection instrumentation shall be provided to monitor caustic scrubber recirculation line flow. Upon detection of low flow (setpoint **TBD**), feed to the operating melter shall be terminated (LFP/LCP systems). The method of feed termination is by isolating air and water to the melter feed ADS pumps. A timed delay in water isolation is allowed for flushing activities, with related analytical limits and setpoints accounting for this time delay. [Sections 4.4.9.1, 4.4.9.3, Appendix 4A, 5.5.6, PDSA - LAW Facility] (F.2.20)

Basis Discussion: Terminating feed to the melter on detection of low flow in the caustic scrubber recirculation line (corresponding to a loss of capability to maintain required loop seal liquid level), ensures that the NO_x hazard eliminated (due to subsequent cold cap burnoff) from the melter offgas system before loop seal liquid levels drop to a point that would allow in-leakage into the melter offgas system through the drain line.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to determine the minimum flow rate required for the caustic scrubber recirculation line.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock terminates feed to the melter upon detection of low flow rate in the recirculation line.	
T	SU/ COM	Test to verify the interlock terminates feed to the melter upon detection of low flow rate in the recirculation line.	

3.9.2.6.4 Caustic Scrubber Bypass Valve Not Closed

Requirement: A position switch on the caustic scrubber bypass valve shall be provided to monitor the position of the valve. Upon detection of the caustic scrubber bypass valve no longer being closed, the following actions shall occur:

- Isolate power to the catalytic oxidizer electric heater
- Isolate the ammonia supply to the SCO/SCR skid
- Open the SCO/SCR bypass valve

[Sections 4.4.37.3, 5.5.31, PDSA - LAW Facility] (F.2.21)

Basis Discussion: The caustic scrubber bypass interlock serves to prevent a significant quantity of high temperature offgas from bypassing the caustic scrubber and impacting the safety function of the melter offgas exhausters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection that the caustic scrubber bypass valve is not closed.	
T	SU/ COM	Test to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection that the bypass valve is no longer closed.	Perform as part of the integrated system test with PPJ

3.9.2.6.5 Caustic Scrubber High Outlet Temperature Interlock

Requirement: Temperature instrumentation downstream of the caustic scrubber unit outlet shall be provided to monitor offgas temperatures. Upon detection of high temperature (setpoint **TBD**) downstream of the caustic scrubber unit outlet, the following actions shall occur:

- Isolate power to the catalytic oxidizer electric heater
- Isolate the ammonia supply to the SCO/SCR skid
- Open the SCO/SCR skid bypass valve.

[Sections 4.4.36.3, Appendix 4A, 5.5.30, PDSA - LAW Facility] (F.2.22)

Basis Discussion: The caustic scrubber high outlet temperature interlock serves to prevent a significant quantity of high temperature offgas from impacting the safety function of the melter offgas exhausters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum allowable offgas temperature at the caustic scrubber outlet.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection of high offgas temperature in the caustic scrubber outlet.	
T	SU/ COM	Test to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection of high offgas temperature in the caustic scrubber outlet.	Perform as part of the integrated system test with PPJ

3.9.2.6.6 Caustic Scrubber Low Pressure Water Supply Interlock

Requirement: Process water line pressure detection instrumentation shall be provided to monitor process water line pressure. Upon detection of low pressure (setpoint **TBD**) in the process water line, the process water line isolation valve shall be closed.

[Sections 4.4.9.1, 4.4.9.3, 4.4.9.5, Appendix 4A, 5.5.6, PDSA - LAW Facility] (F.2.23)

Basis Discussion: Closing the process water line isolation valve prevents a loss of melter depression due to excessive leakage into the melter offgas system as a result of a failed process water line.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the pressure detection threshold that would indicate a leak in the caustic scrubber process water line.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the process water line isolation valve upon detection of low pressure in the process water line.	
T	SU/ COM	Test to verify the interlock closes the process water line isolation valve upon detection of low pressure in the process water line.	Perform as part of the integrated system test with PPJ

3.9.2.7 LVP Header Interlocks

3.9.2.7.1 LVP Low Header Vacuum Interlock

Requirement: LVP header pressure detection instrumentation shall be provided to monitor the header vacuum. Upon detection of low vacuum levels (setpoint **TBD**), the following actions shall occur:

- Set exhausters to a fixed speed

- Open the bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber)
- Close the vessel vent header pressure control valve
- Terminate feed to the melters (LFP/LCP systems). The method of feed termination is by isolating air and water to the melter feed ADS pumps.
- Close the isolation valve on the ammonia supply to the SCR
- Close the isolation valve on the dilution-air supply to the SCR

[Sections 4.4.33.3, Appendix 4A, 5.5.27, PDSA - LAW Facility] (F.2.24)

Basis Discussion: This establishes a known configuration that is much less susceptible to pressure variations due to dynamic process conditions.

It is noted that while other melter feed termination interlocks include a subsequent isolation of the water supply to the ADS pumps due to concerns related to cold cap durations, no such issue exists for low LVP header vacuum. The system can run indefinitely in this configuration, and therefore, water isolation to the ADS pumps is not a required function.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the minimum acceptable vacuum pressure for the LVP header.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, stops feed to the melters, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when a low LVP header vacuum is detected.	
T	SU/ COM	Test to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, stops feed to the melters, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when a low LVP header vacuum is detected.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.7.2 LVP Excessive Header Vacuum Interlock

Requirement: LVP header pressure detection instrumentation shall be provided to monitor the header vacuum. Upon detection of excessive vacuum levels (setpoint **TBD**), the following actions shall occur:

- Set exhausters to a fixed speed
- Open the bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber)
- Close the vessel vent header pressure control valve
- Close the isolation valve on the ammonia supply to the SCR
- Close the isolation valve on the dilution-air supply to the SCR

[Sections 4.4.34.3, Appendix 4A, 5.5.28, PDSA - LAW Facility] (F.2.25)

Basis Discussion: This establishes a known configuration that is much less susceptible to pressure variations due to dynamic process conditions.

- The LVP header excessive vacuum interlock causes each exhauster's ASD to command its exhauster to go to a fixed speed. With at least two exhausters at this fixed speed and the system placed in the configuration resulting from the other interlock functions, the LVP header will maintain an acceptable level of vacuum that will support melter depression, but will not exceed the vacuum rating of the LAW melters.
- The LVP header excessive vacuum interlock actuates closed the vessel vent header pressure control valve. A bypass line around the valve with an orifice exists, allowing a limited flow from the process vessels.
- The LVP header excessive vacuum interlock actuates open the bypass valves in the secondary offgas process system (i.e., mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber). This establishes a known configuration that is much less susceptible to pressure variations due to dynamic process conditions.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum acceptable vacuum for the LVP header.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when excessive LVP header vacuum is detected.	
T	SU/ COM	Test to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when excessive LVP header vacuum is detected.	Perform as part of the integrated system test with PPJ

3.9.2.8 Exhauster Interlocks

3.9.2.8.1 Exhauster Normal Air Purge Low Pressure Interlock

Requirement: Pressure detection instrumentation on the normal purge air supply to the exhauster shaft seals shall be provided to monitor pressure levels. Upon detection of low pressure (setpoint **TBD**) in the normal purge air supply, the following actions shall occur:

- Close the isolation valve between the exhauster shaft seals and the normal air purge supply
- Open the isolation valve between the exhauster shaft seals and the backup air purge supply

[Sections 4.4.43.3, 5.5.33, PDSA - LAW Facility] (F.2.26)

Basis Discussion: The melter offgas system exhausters have shaft seals that are provided with purge air. A loss of the purge air has the potential to result in failure of the shaft seals with a leakage of offgas into the exhauster

room and risk of chemical exposures to facility workers. To protect against a loss of normal purge air flow, a backup arrangement for providing safety exhaust purge air via a separate bottled source for each exhauster is provided in the design. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the minimum acceptable pressure for the normal purge air supply to maintain the shaft seal.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock closes the normal supply isolation valve, and opens the backup supply isolation valve upon detection of low pressure in the normal purge air supply.	
T	SU/ COM	Test to verify the interlock closes the normal supply isolation valve, and opens the backup supply isolation valve upon detection of low pressure in the normal purge air supply.	Perform as part of the integrated system test with PPJ

3.9.2.8.2 Exhauster Backup Air Purge Low Pressure Interlock

Requirement: Pressure detection instrumentation on the backup (bottle) purge air supply to the exhauster shaft seals shall be provided to monitor pressure levels. Upon detection of low pressure (setpoint **TBD**) in the backup purge air supply, feed to both LAW melters shall be terminated (LFP/LCP systems). The method of feed termination is by first isolating air to the melter feed ADS pumps, followed by the isolation of water (after line flushes, as necessary) to the melter feed pumps. [Sections 4.4.43.3, Appendix 4A, 5.5.33, PDSA - LAW Facility] (F.2.27)

Basis Discussion: The exhausters have shaft seals that are normally supplied with air from the plant air supply to provide cooling and maintain exhauster housing confinement. A backup bottled purge air supply is also provided for each exhauster to maintain shaft seal confinement on loss of pressure from the normal plant air supply. As a precaution against eventual depletion of the backup bottle supply, feed to both melters is terminated on detection of low pressure in any of the backup bottled air supplies (indicative of having only 2 hours of backup bottled purge air remaining). [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the minimum acceptable pressure for the backup purge air supply.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify the interlock terminates feed to both melters upon detection of low pressure in the backup purge air supply.	
T	SU/ COM	Test to verify the interlock terminates feed to both melters upon detection of low pressure in the backup purge air supply.	Perform as part of the integrated system test with PPJ and LFP/LCP

3.9.2.8.3 Exhauster Backup Purge Air Mission Time

Requirement: The melter offgas exhauster backup purge air source shall provide adequate pressure to the exhauster shafts seals for a minimum of 2 hours after the isolation of melter feed. [Sections 4.4.43.1, 4.4.43.5 PDSA - LAW Facility]

Basis Discussion: As a precaution against eventual depletion of the backup bottle supply, feed to both melters is terminated on detection of low pressure in any of the backup bottled air supplies (indicative of having only 2 hours of backup bottled purge air remaining). The 2 hour mission time ensures that before any of the exhauster shaft seals fail, the cold cap will be reduced sufficiently that any potential releases into the exhauster rooms are below the exposure standards. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an Analysis to determine the minimum pressure required at the backup purge air to maintain confinement by the exhauster shaft seals for 2 hours after the termination of melter feed.	
R	ENG	Review design of the melter offgas exhauster backup purge air to verify it will provide adequate pressure to the shaft seals to maintain confinement for 2 hours after the termination of melter feed.	
T	SU/ COM	Test to verify the exhauster backup purge air supplies adequate pressure to the exhauster shaft seals to maintain confinement of melter offgas for 2 hours following isolation of the melter feed.	Pressures experienced at the exhauster shaft seals should be actual or simulated for normal melter offgassing operation.

3.9.2.9 Interface with LMP System

The following interlocks are originated in the LMP system, and the complete interlocks are described in the LMP System Design Description document. These interlocks are listed here for interface/functionality purposes.

3.9.2.9.1 LMP Melter Plenum High Pressure Interlock

Requirement: Upon receipt of a high melter plenum pressure (reduced vacuum) signal from the LMP system (via PPJ), the LOP system shall take the following actions:

- Stop injection of air to the melter film coolers
- Stop demineralized water flow to the melter film coolers
- Stop injection of process air to the WESP
- Open *isolation valves on the* standby offgas line

[Sections 4.4.8.3, 5.5.5, Appendix 4A, PDSA - LAW Facility] (F.2.28)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design for incorporation of the system specific interlock physical components.	Additional verification criteria including setpoint determination and testing for this interlock are established in the LMP SDD.

3.9.2.10 Interface with UPE System

The following interlocks are originated in the UPE system, and the complete interlocks are described in the UPE System Design Description document. These interlocks are listed here for interface/functionality purposes.

3.9.2.10.1 UPE Loss of Normal Power Interlock

Requirement: Upon receipt of a loss of normal power signal from the UPE system (via PPJ), the LOP and LVP systems shall take the following actions:

- Stop injection of process air to the melter film coolers
- Stop demineralized water flow to the melter film coolers
- Stop injection of process air to the WESP
- Fully open the melter offgas flow control valve, downstream of the WESP
- Close the vessel vent header pressure control. A bypass line around the valve with an orifice exists, allowing a limited flow from the process vessels. This limited flow is allowed for in the control strategy selection.
- Open bypass valves in the secondary offgas process system (mercury mitigation skid, catalytic oxidizer/reducer skid, and the caustic scrubber)

[Sections 4.4.10.3, 5.5.7, PDSA - LAW Facility] (F.2.29)

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design for incorporation of the system specific interlock physical components.	Additional verification criteria for this interlock are established in the UPE SDD.

3.9.3 System Interface Requirements

3.9.3.1 Process Control System - Instruments

Requirement: The LOP and LVP systems' instruments shall use standard commercially available instrumentation and communication protocols to interconnect to the PCJ system. [Section 9.4.1, BOD]

Basis Discussion: Instrumentation for normal process control utilize, to the extent practicable, Foundation Fieldbus (ISA 50.02) technology and Profibus DP Fieldbus is used where Foundation Fieldbus is not appropriate.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design, including applicable procurement documentation, to verify system instruments that interconnect to the PCJ meet the identified commercial standard.	May be documented in assessment/evaluation report.

3.9.4 Other Technical, Specialty, Operations and Maintenance Requirements

Not used.

3.10 Other Structures, Systems, and Component Requirements

3.10.1 Mission and Functional / Performance Requirements (Including States and Modes)

3.10.1.1 Tank System Design

Requirement: The LOP and LVP systems' tank system shall be capable of preventing the escape of vapors, fumes, or other emissions into the air if the tank holds materials that are acutely or chronically toxic by inhalation. [Section 14.10.1, BOD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify tank systems have the capability to prevent leakage of vapors and fumes.	

3.10.2 Nuclear Safety, ALARA, Environmental and Other Regulatory Requirements

3.10.2.1 Function of the Stack

Requirement: The LOP and LVP systems shall ensure that the release of melter offgas from the facility occurs at an elevated level of about 200 ft. above ground-level. [Sections 4.4.1.1, 4.4.1.3, Appendix 4A, PDSA - LAW Facility] (A.8)

Basis Discussion: Enhanced dispersion is provided by elevating the contaminated gas plume through the exhaust stack. The elevated release through the stack decreases the chemical exposure to the public and co-located worker to acceptable levels. Radiological exposures were well within applicable limits, even when calculated for a ground-level release. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify offgas release is about 200 ft.	

3.10.3 System Interface Requirements

3.10.3.1 Inspections

Requirement: The LOP and LVP systems shall provide the ability to conduct appropriate periodic inspections and functional testing to ensure structural and leak-tight integrity of components, operability and performance of components, and operability of the systems as a whole. [Section 15.1, ORD]

Basis Discussion: None

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify provisions for inspections and functional testing to ensure structural and leak-tight integrity of components.	

3.10.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.10.4.1 Vessel Flushing and Washing

Requirement: The LOP and LVP systems' process vessels shall be equipped with interior perimeter spray rings, or equivalent, for decontamination or flushing. [Section 14.2, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify vessels are equipped with interior perimeter spray rings, or equivalent, for decontamination or flushing.	

3.10.4.2 Piping without Suspended Solids

Requirement: The LOP and LVP systems' piping that contains fluids without suspended solids may be routed level and shall have sufficient high point vents and low point drains to ensure that all of the piping can be drained for maintenance and decommissioning. [Section 14.3, ORD]

Basis Discussion: Utility piping containing fluids without suspended solids can be level with high point vents and low point drains such that the piping can be drained. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that piping has sufficient high point vents and low point drains to ensure that all of the piping can be drained.	

3.10.4.3 Piping with Suspended Solids

Requirement: The LOP and LVP systems' piping that contains fluids with suspended solids shall have high point vents, low point drains, and be sloped to drains/vessels as necessary to ensure that the fluids and solids can be flushed and drained from the piping. [Section 14.3, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify that piping which contains fluids with suspended solids have sufficient high point vents, low point drains and are sloped to drains/vessels.	

3.10.4.4 Piping Flushing

Requirement: The LOP and LVP systems' piping shall provide the capability to be flushed and drained with no traps or pockets that can accumulate liquids or solids. Piping shall be free-draining without traps/seals, unless there are traps/seals that will allow operator action for drainage. [Section 7.1, 14.1, and 14.3, ORD]

Basis Discussion: The piping includes, where appropriate, vapor handling vessels, exhaust duct systems, seal pots, and seal loops. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify piping is capable of being flushed and drained, and does not include traps or pockets that can accumulate liquids or solids	

3.10.4.5 Piping Flushes – Transfer Lines

Requirement: The LOP and LVP systems' piping flushing facilities shall provide for normal flushes of transfer lines and for unplugging efforts when necessary between LAW and the Pretreatment (PT) Facilities and EMF facilities. [Section 14.3, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis to verify required piping flushing facilities for normal flushes of transfer lines and for unplugging efforts when necessary between LAW and the Pretreatment (PT) and EMF facilities.	May be documented in assessment/evaluation report.

3.10.4.6 Remotely Operated Valves

Requirement: The LOP and LVP systems' valves shall be capable of being remotely operated where valves are used in routine operations, or where accessibility is difficult. [Section 14.4, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify valves which are difficult to access or are used for routine operations are capable of being remotely operated.	May be documented in assessment/evaluation report.

3.10.4.7 Decontamination

Requirement: The LOP and LVP systems' piping and valve systems shall be capable of adding decontamination chemicals to the process vessels. [Section 14.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to determine which process vessels require the capability of adding decontamination chemicals.	May be documented in assessment/evaluation report.
R	ENG	Review design to verify process vessels that require the capability of adding decontamination chemicals are capable of performing that function.	

3.10.4.8 Bulges

Requirement: The LOP and LVP systems' equipment requiring maintenance and that comes into contact with the radioactive process fluids shall be located in stainless steel bulges. Wash rings shall be provided for wash-down of all areas of the bulge. [Section 10.4, ORD]

Basis Discussion: Process isolation valves, pumps, and instruments are examples of equipment that require maintenance and would be located in bulges. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify stainless steel bulges are used to contain equipment requiring maintenance that come into contact with the radioactive process fluids and wash rings are provided.	

3.10.4.9 Bulges Contamination Prevention

Requirement: The LOP and LVP systems' relief valves and rupture disks shall not release waste into the bulge. [Section 10.4, ORD]

Basis Discussion: Minimizes contamination and exposure. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify relief valves and rupture disks do not release waste in the bulge area.	

3.10.4.10 Bulges Shielding

Requirement: The LOP and LVP systems' bulges shall provide adequate shielding to allow access to the bulge internals. [Section 10.4, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify bulges provide adequate shielding to allow access to the bulge internals.	

3.10.4.11 Bulge Access Ports

Requirement: The LOP and LVP systems' bulges shall include access ports to allow inspection of bulge internals using closed circuit television or fiber-optics without the need to remove bulge shielding. [Section 10.4, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify access ports are provided to allow inspection of bulge internals using CCTV or fiber-optics without the need to remove bulge shielding.	

3.10.4.12 Valves Position Indicators

Requirement: The LOP and LVP systems' valves used in process service, or supporting the process in bulges or other remote locations, shall be equipped with highly reliable position indicators. [Section 14.4, ORD]

Basis Discussion: Remotely operated valves normally repositioned to support processing (this includes support systems) should have position indication from directly coupled positioning mechanisms unless other indications are available of valve positon such as flow, level, pressure, etc. The indication signal can be visual, mechanical, electric, or electronic based on the valve location and type of valve. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify process valves in bulges or remote locations are equipped with highly reliable position indicators.	

3.10.4.13 Pressure Relief Valve Configuration

Requirement: The LOP and LVP systems' pressure relief valves shall be configured using a full port three-way valve, dual PSVs, and drain valves on each leg, unless a redundant train is provided. [Section 14.4, ORD]

Basis Discussion: Configuration allows a pressure relief valve to be removed from service for maintenance without shutting down the system while maintaining over-pressure protection.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify pressure relief valves are configured correctly.	

3.10.4.14 Valves Damage from Water Hammers

Requirement: The LOP and LVP systems' automatic valve operator closure device shall be sufficiently slow to prevent water hammer. [Section 14.4, ORD]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify automatic valve operator closure devices are sufficiently slow to prevent water hammer.	

3.10.4.15 Process Vessels with Heating/Cooling Jackets or Coils

Requirement: The LOP and LVP systems' vessels which have a heat transfer coil inside shall provide a coil support system to avoid wear due to thermal cycling. [Section 14.2, ORD]

Basis Discussion: The SBS Condensate Vessel has a cooling water jacket. The SBS has internal cooling coils and a cooling water jacket.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify vessels which have a heat transfer coil inside provide a coil support system to avoid wear due to thermal cycling.	

3.10.4.16 Maintainable Equipment Location

Requirement: The LOP and LVP systems' maintainable equipment components, such as drive motors, shall be located out of high radiation cave, cell, and bulge areas to the extent practical. [Section 7.1, ORD]

Basis Discussion: None. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review design to verify maintainable equipment is located out of high radiation cave, cell, and bulge areas to the extent practical.	May be documented in assessment/evaluation report.

3.10.4.17 Isolation of Components/Equipment

Requirement: The LOP and LVP systems shall allow for items and equipment to be periodically locked out and isolated and provide visible indication of the device position. High-energy systems (fluid systems with operating parameters > 200 °F and (or) 500 psig) shall use the double block and bleed method of isolation for all paths where fluid could cross the work boundary for hands-on maintenance. [Section 19.14, ORD]

Basis Discussion: The double block and bleed requirement does not apply to relief valves, which require a full port three-way valve configuration for systems that cannot be easily isolated, or where isolation would have a negative impact on safety or availability. [ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
R	ENG	Review of design to verify any high energy isolation points are provided with double block and bleed arrangement.	May be documented in an evaluation/assessment report.
R	ENG	Review of design to verify components and equipment can be isolated and locked out providing visible indication of the position of the isolating device.	May be documented in an evaluation/assessment report.

3.11 Relevant Codes and Standards

3.11.1 Codes of Record

Table 3-6 identifies relevant external codes and standards applicable to the [LOP and LVP] design. Use of the *Engineering, Procurement, and Construction (EPC) Code of Record*, 24590-WTP-COR-MGT-15-00001 is typically invoked in the design process through the documents identified in Section 3.11.2. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from the Code of Record for allocation to SSCs.

In some cases, the expected means of verification may be established on the basis of tests or other criteria required by the codes and standards. This does not necessarily include verification or testing more appropriately defined in the procurement of individual sub-systems or components, or verification or testing that is a routine activity defined by specifications and/or procedures used by construction and startup.

Table 3-6 LOP and LVP Applicable Codes and Standards

Implementing Codes and Standards: **[24590-WTP-COR-MGT-15-00001, Rev 0, Engineering, Procurement, and Construction (EPC) Code of Record]**
• ANSI/ANS 58.8-1994, Time Response Design Criteria for Safety-Related Operator Actions[2]
• ANSI/ISA-67.04.01-2006, *Setpoints for Nuclear Safety-Related Instrumentation*, as tailored in Appendix C of the SRD[2]
• ANSI-K61.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*[1]
• ASME AG-1 Code on Nuclear Air and Gas Treatment[2]
• ASME B31.3-1996, *Process Piping*, as tailored in Appendix C of the SRD[1]
• ASME Section VIII Divisions 1, and Division 2, Boiler and Pressure Vessel Code, *Rules for Construction of Pressure Vessels*[1]
• ASME Boiler and Pressure Vessel Code, Section IX, *Welding and Brazing Qualifications*[1]
• ASME N509, *Nuclear Power Plant Air-Cleaning Units and Components*[1]
• ASME N510-1989 (R 1995), Testing of Nuclear Air Cleaning Systems[2]
• ASME PTC 10, *Performance Test Codes on Compressors and Exhausters*[1]
• AWS D1.1, *Structural Welding Code - Steel.* [1]
• AWS D1.3, *Structural Welding Code, Sheet Steel*[1]
• AWS D1.6, *Structural Welding Code - Stainless Steel* [1]
• AWS D9.1, *Sheet Metal Welding Code*[1]
• AWS D14.6, *Specification for Welding of Rotating Elements of Equipment*[1]
• DOE-STD-1020-94 (Change 1, 1996), Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities, as tailored in Appendix C[2]
• IEEE 323-83, Qualifying Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix C of the SRD[2]
• IEEE 338-1987, *Standard Criteria for Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems*, as tailored in Appendix C of the SRD[1]
• IEEE 344-1987 (R1993), Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, as tailored in Appendix C[2]
• IEEE 382-1996, Standard for Qualification of Actuators for Power-Operated Valve Assemblies With Safety-Related Functions for Nuclear Power Plants, as tailored in Appendix C[2]
• IEEE 384-1992, *Standard Criteria for Independence of Class 1E Equipment and Circuits*, as tailored in Appendix C of the SRD[1]
• IEEE 497-2002, *Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations* as tailored in Appendix C of the SRD
• IEEE 628, *Standard Criteria for the Design, Installation, and Qualification of Raceway Systems for Class 1E Circuits for Nuclear Power Generating Stations*[1]
• IEEE 1023-88, *Guide for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations*
• ISA-S84.01-1996, *Application of Safety Instrumented Systems for the Process Industries*[1]

Table 3-6 LOP and LVP Applicable Codes and Standards

• ISO 1940-1:2003, *Mechanical Vibration - Balance Quality Requirements For Rotors in A Constant (Rigid) State - Part 1: Specification And Verification Of Balance Tolerances*[1]
• ISO-4706, *Gas Cylinders – Refillable Welded Steel Cylinders – Test pressure 60 bar and below*[1]
• ISO-TR-13763, *Safety and performance criteria for seamless gas cylinders*[1]
• NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)* [1]
• NFPA 70-1999, *National Electrical Code*[1]
• UBC. *Uniform Building Code*[1]
• WAC 173-303, *Washington Administrative Code - Dangerous Waste Regulations*

[1] The LAW-PDSA *specifies that design of selected portions* of the LOP/LVP system per this code or standard is a credited design feature to help ensure the robustness of the design in support of the nuclear safety hazards analysis and selection of controls.
[2] This code or standard from the SRD applies to components of the LOP/LVP system that have a safety function.

3.11.2 WTP Design Criteria, Design Guides, and General Specifications

Table 3-7 identifies relevant discipline design criteria, guides, and general specifications applicable to the LOP and LVP systems. Use of these documents to develop the detailed design of SSCs is governed by engineering procedures. The majority of requirements, contained within this document are derived from external codes and standards, or are specified methods and approaches to achieve standardization and consistency of design. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from these documents for tracing and verification, or to define how direction provided by these documents is applicable and allocated (or not) to individual SSCs.

Table 3-7 WTP Design Guides, and General Specifications Applicable to LOP and LVP

Document Number	Title
Design Criteria Documents	
24590-WTP-DC-M-06-001	*Mechanical Systems Design Criteria*
24590-WTP-DC-E-01-001	*Electrical Design Criteria*
24590-WTP-DC-E-06-002	*Design Criteria for Independence of Safety Equipment and Circuits*
24590-WTP-DC-ENG-06-001	*Design Criteria for Environmental and Natural Phenomena Hazard Qualification of Structures Systems and Components*
24590-WTP-DC-PS-01-001	*Pipe Stress Design Criteria Including "Pipe Stress Criteria" and "Span Method Criteria"*
24590-WTP-DC-PS-01-002	*Pipe Support Design Criteria*
24590-WTP-DC-ST-04-001	*Seismic Analysis and Design Criteria*
Design Guides	
24590-WTP-GPG-ENG-004	*Design Guide Pipe Stress, Pipe Layout, and Support Spacing*
24590-WTP-GPG-ENG-005	*Engineering Design Guide for Pipe Support*
24590-WTP-GPG-ENG-086	*Equipment Environmental Qualification*
24590-WTP-GPG-ENG-0094	*Pipe Design Work Process*
24590-WTP-GPG-ENG-0099	*Design Verification of Plant Design Deliverables*

Table 3-7 WTP Design Guides, and General Specifications Applicable to LOP and LVP

Document Number	Title
24590-WTP-GPG-ENG-0103	*Equipment Seismic Qualification*
24590-WTP-GPG-ENG-0109	*Accessibility Review of Equipment and Components*
24590-WTP-GPG-ENG-0118	*Piping Component Stock Codes*
24590-WTP-GPG-ENG-0119	*Isometric Drawings Production*
24590-WTP-GPG-ENG-0127	*Processing Engineering Calculations*
24590-WTP-GPG-ENG-0140	*Hot Pipe Penetrations Through Concrete*
24590-WTP-GPG-ENG-0141	*WTP Radiation Damage Thresholds for Non-Metallic Materials*
24590-WTP-GPG-ENG-0144	*Piping Interface with Flexible Equipment-Stress Analysis Design Guide*
24590-WTP-GPG-ENG-0145	*SC-IIIE Piping - Stress Analysis Design Guide*
24590-WTP-GPG-ENG-0146	*Piping Coating System Selection Guide*
24590-WTP-GPG-ENG-0149	*Piping Classification Guide*
24590-WTP-GPG-ENG-0150	*Plant Design/Mechanical Systems Equipment Interfaces: Terminal End Equipment*
24590-WTP-GPG-ENG-0153	*Safety Instrumentation - Independent Protection Layer Identification*
24590-WTP-GPG-ENG-0159	*Single Failure Analysis Process for Mechanical, HVAC, and Control Systems*
24590-WTP-GPG-ENG-0165	*Pipe Stress and Supports Confirmation*
24590-WTP-GPG-J-005	*Control Systems Interfaces*
24590-WTP-GPG-J-014	*Control Systems Design Process Guide*
24590-WTP-GPG-J-015	*Safety Instrumented System Implementation*
24590-WTP-GPG-J-016	*Control Valve Sizing*
24590-WTP-GPG-J-017	*WTP Seismic Category Application to C&I Systems*
24590-WTP-GPG-J-0057	*Setpoint Calculations*
24590-WTP-GPG-M-002	*Hydraulic Seals*
24590-WTP-GPG-M-011	*Pipe Sizing for Compressible Flow*
24590-WTP-GPG-M-012	*Pump Net Positive Suction Head*
24590-WTP-GPG-M-013	*Plant Wash System Design*
24590-WTP-GPG-M-016	*Pipe Sizing for Lines with Liquids Containing Solids - Bingham Plastic Model*
24590-WTP-GPG-M-017	*Design Parameters & Test Pressures for Equipment & Piping*
24590-WTP-GPG-M-019	*Vessel Sizing*
24590-WTP-GPG-M-022	*Liquid and Vapor Line Sizing By Formula*
24590-WTP-GPG-M-023	*Other Losses in Piping Systems*
24590-WTP-GPG-M-027	*Recommended Slopes for Piping Systems*
24590-WTP-GPG-M-028	*Vent, Drain, and Root Valve Sizing and Selection for Piping Systems*
24590-WTP-GPG-M-032	*Vessel Overflow and Gravity Line Sizing*
24590-WTP-GPG-M-036	*Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts*
24590-WTP-GPG-M-047	*Preparation of Corrosion Evaluations*
24590-WTP-GPG-M-050	*Pressure Vessel and Heat Exchanger Design*
24590-WTP-GPG-M-052	*Specifying Design Cycles for Equipment and Piping*

Table 3-7 WTP Design Guides, and General Specifications Applicable to LOP and LVP

Document Number	Title
24590-WTP-GPG-M-0058	*Minimum Flow Velocity for Slurry Lines*
24590-WTP-GPG-M-0059	*Avoiding Chemical Line Plugging - Plant Design Considerations*
24590-WTP-GPG-M-0061	*Vessel Structural Analysis and ASME Section VIII Evaluation*
24590-WTP-GPG-PL-002	*Plant Design Material Control Guide*
24590-WTP-GPG-SRAD-001	*Design Guide for ALARA*
Specifications	
24590-WTP-3PS-FB01-T0001	*Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment and Tanks*
24590-WTP-3PS-G000-T0002	*Engineering Specification for Positive Material Identification (PMI) for Shop Fabrication*
24590-WTP-3PS-G000-T0015	*Engineering Specification for Environmental Qualification of Mechanical Equipment*
24590-WTP-3PS-JQ00-T0004	*Engineering Specification for Management of Supplier Software*
24590-WTP-3PS-JQ00-T0005	*Engineering Specification for Management of Supplier Safety Software*
24590-WTP-3PS-JQ06-T0005	*Engineering Specification for Environmental Qualification of Control and Electrical Systems and Components*
24590-WTP-3PS-JQ07-T0001	*Engineering Specification for Instrumentation for Package Systems*
24590-WTP-3PS-JQ08-T0001	*Engineering Specification for Construction and Installation of Controls and Instrumentation*
24590-WTP-3PS-MACS-T0004	*Single Stage High Integrity Centrifugal Fans and Blowers (AG-1)*
24590-WTP-3PS-MV00-T0001	*Engineering Specification for Pressure Vessel Design and Fabrication*
24590-WTP-3PS-MV00-T0002	*Engineering Specification for Seismic Qualification Criteria for Pressure Vessels*
24590-WTP-3PS-MV00-T0003	*Engineering Specification for Pressure Vessel Fatigue Analysis*
24590-WTP-3PS-NWP0-T0001	*Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping*
24590-WTP-3PS-PB01-T0001	*Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges*
24590-WTP-3PS-PH01-T0001	*Engineering Specification for Technical Supply Conditions 'QL' Pipe Supports*
24590 WTP 3PS PS02 T0001	*Engineering Specification for Shop Fabrication of Piping*

4 System Description

4.1 Configuration Information

All values used throughout this section are nominal unless otherwise stated.

Design details associated with the incorporation of the DFLAW operating configuration have not been included in Section 4 of this document at this time. Section 4 will be updated to include DFLAW content at a later date once the detailed design process for DFLAW has been completed.

The LOP/LVP systems are designed to collect, cool, and treat the offgas from the LAW melters so that it conforms to relevant federal, state, and local air emissions requirements at the point of discharge from the facility exhaust stack. The offgas stream generated during the vitrification of melter feedstock consists of air (from controlled in-leakage), steam (evaporation of feed moisture and hydroxide decomposition), gases (e.g., CO_2, NO_x, SO_x, HCl, HF from thermal decomposition of salts and organic material), aerosols and particulate (from dried melter feed before melting), mercury and iodine (volatilizing form glass melt), and radioactive material. The offgas system is critical to the successful processing of that part of the tank waste which will decompose and or volatilize when the feed is heated to the glass forming temperature. Confinement of all volatile components is achieved by the exhausters maintaining a negative pressure through an unobstructed LOP/LVP header pathway up to the melter plenum while there is a cold cap present in the melter.

When processing feed during normal operation, the melter is said to have a cold cap. The cold cap is the layer of feed on the surface of the molten glass before it is decomposed by heat into a volatile phase. This volatile phase will be processed by the LOP/LVP system into a more refractory glass phase, which will be liquefied and used to fill stainless steel containers. Both phases contain hazardous constituents which need to be contained and confined. During upset conditions where the feed is stopped, a two-hour window of time is allowed for the complete decomposition of the cold cap and stabilization of the glass pool. After the cold cap disappears, the volatile hazard is minimized. This two-hour window to minimize the offgas hazard is maintained by UPE, which maintain exhauster operation for cold cap elimination.

The scope of the LOP system covers the post melter primary offgas system including film coolers, SBSs, SBS condensate vessels, WESPs, and associated WESP condensate vessels. The scope of the subsequent LVP system covers preheaters, HEPA filters, the mercury adsorber, SCO/SCR, caustic scrubber, caustic scrubber collections tank, vacuum exhausters, and the discharge stack.

The purpose of the LOP system is to cool the offgas; remove aerosols and particulate matter; and reduce the acid gases generated by the melter, done through the wet scrubbing and electrostatic precipitation processes; see process flow diagrams (PFD) 24590-LAW-M5-V17T-00004, -00005, -00007, and -00008) (revision 4 – 2004).

The purpose of the successive LVP system is to remove the remaining particulates and radioactivity, mercury, VOCs, nitrogen oxides, iodine and acid gases through HEPA filtration, adsorption, oxidation / reduction and caustic scrubbing; see PFDs 24590-LAW-M5-V17T-00010, and -00011) (revision 4 and 5 – 2004 and 2006).

The vessel ventilation stream is joined with the LOP system for treatment by the LVP system.

The LOP and LVP unit emission and exhaust path piping and abatement equipment confines and directs melter offgas from the melter through the exhaust stack to protect the public, environment, operating staff, and co-located workers from radionuclide and chemical exposure during all operating conditions (normal and off-normal) and during design basis natural phenomona events. It provides an unobstructed flowpath to direct the offgas from the melters to the exhaust stack. It prevents the generation of flammable and explosive gases and precludes the release of I-129, NOx, mercury, and sulfur, as well as any carbon bed fire products. The negative pressure of the LOP/LVP system relative to the surrounding facility up to the exhausters is important to how the system maintains containment. Interface with an uninterruptible power supply ensures exhauster operability and flow through the offgas system until the hazards of a melter cold cap burnoff are eliminated. This system includes as low as reasonably achievable (ALARA) design features and best achievable radionuclide control technology (BARCT), as well as best available control technology (BACT) requirements. The design supports responses to off-normal conditions that could affect LAW Facility operations.

4.1.1 Description of System, Subsystems, and Major Components

Refer to piping and instrumentation diagrams (P&ID):

24590-LAW-M6-LOP-00001004 (Melter 1), and
24590-LAW-M6-LOP-00002004 (Melter 2)

Refer to calculations: 24590-LAW-MKC-LOP-00005,
24590-LAW-M6C-LOP-00008 (overpress protection eval)

Refer to datasheets: 24590-LAW-M0Q-LOP-00001

Figure 4-1 Block Diagram for LOP/LVP Systems

A functional block diagram of the LOP/LVP systems and their associated interfaces is provided in Figure 2-3.

The visible tag number for each component described in the following sections provides the reader with additional understanding and correlation to the diagrams in this section.

- Film Coolers (LOP–FCLR–00001, LOP–FCLR–00002, LOP–FCLR–00003, and LOP–FCLR–00004)
- Melter pressure control subsystem
  - Melter pressure controls/instrumentation
  - Specially engineered piping spools with bellows through a wall box
- SBS (LOP–SCB–00001, LOP–SCB-00002)
- SBS condensate receiver vessel (LOP–VSL–00001, LOP–VSL-00002)
  - RLD condensate collection vessel (RLD-VSL-00005)
  - Overflows to RLD plant wash vessel (RLD-VSL-00003)
- WESP (LOP-WESP-00001, LOP-WESP-00002)
  - WESP electrodes and power supply (PSUP) (LVE-PSUP-20201, LVE-PSUP-20202)
  - RLD condensate collection vessel (RLD-VSL-00004)
  - Overflows to RLD plant wash vessel (RLD-VSL-00005)

The following major equipment is part of the LVP

- HEPA filter electric preheaters (LVP-HTR-00001A/B, and LVP-HTR-00003A/B)
- HEPA Filters (LVP-HEPA-00001A and LVP-HEPA-00002A, followed by LVP-HEPA-00003A); and an auxiliary train (LVP-HEPA-00001B, followed by LVP-HEPA-00002B)
  - Piping, utility piping (includes supports and welds), valves
- Activated carbon mercury adsorber skid (LVP-SKID-00001)
  - Activated carbon adsorber (LVP-ADBR-00001A and LVP-ADBR-00001B)
- SCO/ SCR skid (LVP-SKID-00002)
  - Recuperative heat exchanger (LVP-HX-00001)
  - Electric heater (LVP-HTR-00002)
  - Selective catalytic oxidizer (SCO) (LVP-SCO-00001)

- Ammonia / air dilution skid (LVP-SKID-00003)
  - Selective catalytic reducer (SCR) (LVP-SCR-00001)
  - HEPA filters (LVP-HEPA-00004A and LVP-HEPA-00004B)
  - Piping (includes supports and welds), valves
- Caustic scrubber (LVP-SCB-00001)
  - Scrubber bottoms collection tank (LVP-TK-00001)
  - Recirculation loop
- Exhausters (LVP-EXHR-00001A, LVP-EXHR-00001B, LVP-EXHR-00001C)
  - Connected to UPS (UPE-UPS-20304, UPE-UPS-20305, UPE-UPS-20306) (covered in separate SDD)
  - Exhaust stack
- Piping (includes supports and welds), valves

4.1.1.1 The following major equipment is part of LOP

4.1.1.1.1 Film Coolers

Refer to P&IDs: 24590-LAW-M6-LOP-00001005 (melter 1)
24590-LAW-M6-LOP-00002005 (melter 2)
24590-LAW-M6-LOP-00004002 (melter 1)
24590-LAW-M6-LOP-00005002 (melter 2)

Refer to calculation: 24590-LAW-M6C-LOP-00004 (line sizing),
24590-LAW-M6C-LOP-00007 (emergency air in-bleed line pressure drop)

When a cold cap is present, the offgas exits the melter at approximately 750 °F and is mixed with injection air in a primary offgas film cooler (LOP-FCLR-00001, -00003). The primary offgas film cooler cools the offgas below the glass sticking temperature to minimize solids deposition on the offgas piping walls. This film cooler is a double-walled pipe designed to introduce air along the walls through a series of 10 slots in the inner wall and perimeter holes to cool the outside surfaces. The injection air that flows along the pipe wall mixes with, and cools, the offgas to approximately 550 °F. An offgas velocity of greater than 50 ft/sec is normally maintained between the melter and the SBS. This velocity helps minimize solids deposition within the primary offgas film cooler and offgas line. A supply of cooling air provides the baseline cooling, which is mixed with pressure control air prior to the film cooler.

When the melter is idled, causing the plenum temperature to rise, the injection air in the primary offgas film cooler provides cooling to approximately 1110 °F to prevent thermal damage to this film cooler and downstream equipment. Since the particulate challenge is reduced, it is no longer necessary to cool the offgas to approximately 600 °F.

4.1.1.1.2 Melter Pressure Control Subsystem

Refer to P&IDs: 24590-LAW-M6-LOP-00004001 (melter 1)
24590-LAW-M6-LOP-00004002 (melter 1)
24590-LAW-M6-LOP-00005001 (melter 2)
24590-LAW-M6-LOP-00005002 (melter 2)

Refer to calculation: 24590-LAW-N1D-LOP-00004 (spool corrosion evaluation)

A primary function of the LOP system is to control the melter plenum pressure. Control air is introduced into the primary offgas film cooler to adjust pressure while maintaining a relatively constant flow of non-condensable gas. If the melter vacuum moves from the normal control setpoint, the flow of control air is adjusted to return the plenum pressure to the setpoint. Changes to the control air flowrate are in turn used to adjust the opening of the offgas flow control valve downstream of the WESP. If the offgas generation rate begins to exceed the capacity of the primary line, the melter vacuum decreases. The control air flowrate decreases accordingly, which in turn causes the valve at the WESP to open, allowing more melter offgas flow.

Injection air is also supplied to a standby offgas film cooler (LOP-FCLR-00002, -00004), which normally vents through the primary offgas film cooler via the melter plenum. The injection air minimizes solids deposition in the standby offgas film cooler. There is only one slot and a refractory shield in the standby film cooler. If any plugging or blockage by particulate deposits occurs in the primary film cooler, thereby reducing the effective flow path and associated melter plenum vacuum, a secondary path to restore vacuum is available through the standby film cooler. When a low vacuum setpoint is reached in the melter plenum, a butterfly valve (LOP-YV-1008, -2008) in the standby offgas line automatically opens to permit offgas flow through the standby offgas film cooler to the SBS, thereby supplementing the primary offgas film cooler in restoring the vacuum in the melter plenum. The offgas is subjected to normal offgas treatment while the feed to the melter is terminated.

Once the upset condition is corrected and melter vacuum is re-established at the normal control setpoint, the standby line is isolated by closing the butterfly valve. When flow is returned exclusively through the primary system, melter feed can be re-initiated.

In the event that the melter pressurizes above 10 in. WG, a relief device opens to allow the melter to vent to the wet process cell and associated C5V ventilation. The relief device could be activated during normal operations; therefore, personnel access is not allowed in the cell unless the melter is idled due to the NO_x hazard. Once the melter pressure is below the relief setpoint, the relief device closes.

The idle melter condition is defined by melter feed off and no gas generation. This also means the plenum temperature rises to near the glass temperature because there is no insulating cold cap on the glass surface. Pressure control is maintained, however there are few variations in flow or pressure. Film cooler flow is maintained to limit the temperature rise at the offgas line. The return to operations from idle is started with water fed to the melter. Steam generation is limited by film boiling as the water cools the plenum to prepare for feed slurry. Cooling the plenum first limits the pressure fluctuations at the start of feed so that the pressure control system can maintain vacuum.

Ten-inch diameter removable spools (LOP-SPOOL-00001 through -00008) connect each film cooler to the SBS; see piping layout drawings 24590-LAW-M61-P23T-00001 and -00030. These spools are designed to handle flow variations up to seven times the normal steam generation rate and three times the normal non-condensable gas generation rate from the melter feed without causing interruption of the melter operation. An analysis of the frequency and magnitude of these surges is provided in report 24590-LAW-RPT-ML-04-0001. The spools and wall penetrations have a design temperature of 1110 °F. Each spool is fabricated from Inconel 625. The spools rise vertically from the film cooler and then slope downward to the SBS.

4.1.1.1.3 Submerged Bed Scrubber

Refer to P&IDs: 24590-LAW-M6-LOP-00001001 (melter 1)
24590-LAW-M6-LOP-00002001 (melter 2)

Refer to calculation: 24590-LAW-M6C-RLD-00006 (condensate VSL-00005 sizing)
24590-LAW-ESQR-ENG-12-0089 (weight/seismic/nozzle load/lift calculations)
24590-QL-POA-MKAS-00001-01-03 (ASME code calculation)
24590-QL-POA-MKAS-00001-01-16 (wt./seismic/nozzle load/lift calculations)
24590-QL-POA-MKAS-00001-01-17 (wt./seismic/nozzle load/lift calculations)
24590-QL-POA-MKAS-00001-01-18 (wt./seismic/nozzle load/lift calculations)
24590-QL-POB-MVA0-00002-03-01 (code design condensate vessel)
24590-QL-POB-MVA0-00002-03-02 (code design condensate vessel)
24590-LAW-N1D-LOP-00001 (vessel corrosion evaluation)

Refer to datasheets: 24590-LAW-MKD-LOP-00008

Offgas from the film coolers enters a packed bed column enclosed by an SBS (LOP-SCB-00001, -00002) for further cooling. Each melter has a dedicated SBS. The column has a diameter of 6 ft, 2 in., and a packed bed height of 24 in. The SBS is 6.5 ft high (tangent to tangent) by 10 ft in diameter with a maximum operating volume of 3,690 gal. Each SBS is fabricated from Hastelloy C-22. The SBS is a passive device designed for aqueous scrubbing of entrained radioactive particulates and removal of aerosols from melter offgas.

The SBS has two offgas inlet lines, one for normal operations and one for standby. The inlet pipes run down through the bed to the packing support plate. The bed retaining walls extend below the support plate, creating a lower skirt to prevent gas from bypassing the packing. A hold-down screen is used to prevent the bed from being carried out by upward flow through the bed. The packing consists of one-inch diameter ceramic spheres. Gas bubbles are formed as the gas passes through holes in the support plate. The bubbles rise through the packed bed and cause the liquid to circulate up through the packing, and hence downward in the annular space outside the packed bed. The packing breaks larger bubbles into smaller ones to increase the gas-to-water contact area and helps increase the particulate removal and heat transfer efficiencies.

The SBS has an offgas inlet flow rate of approximately 1470 SCFM at 600 °F and -10 in. WG. A distribution header inside the SBS circulates the liquid to prevent buildup of captured material in the bed by constantly washing the material away. The SBS is cooled through an exterior half-pipe jacket and two concentric cooling coils in the vessel. Cooling is supplied from the chilled water system (CHW) to maintain the scrubbing liquid at a nominal temperature of 122 °F. The liquid temperature controls the offgas outlet temperature, which maintains the SBS at saturated conditions.

4.1.1.1.3.1 SBS Condensate Receiver Vessel

Refer to P&IDs: 24590-LAW-M6-LOP-00001002 (melter 1)
24590-LAW-M6-LOP-00002002 (melter 2)

Refer to calculation: 24590-CM-POA-MEP0-00001-05-00037 (heat exchanger)
24590-CM-POA-MVA0-00007-01-02 (condensate receipt vessel)
24590-CM-POA-MVA0-00007-01-06 (FEA for nozzles)
24590-QL-POB-MVA0-00002-03-01, -02 (code design vessel 1 and 2)
24590-QL-POB-MVA0-00002-03-09, -10 (ext. thermal loading vessel 1 and 2)
24590-LAW-N1D-LOP-00002 (vessel corrosion evaluation)

As the offgas cools, water vapor condenses and increases the liquid inventory. The liquid overflows into a SBS condensate vessel (LOP-VSL-00001, -00002) located next to the SBS, thereby maintaining a constant liquid depth in the SBS. The SBS condensate vessel has a cooling jacket to further cool the condensate. The condensate vessel is 8 ft, 2 in. high (tangent to tangent) by 12 ft inside diameter with a maximum operating volume of 7,402 gal. The vessel capacity is designed to hold about two days of condensate. Each vessel is fabricated from Alloy 22. This vessel is vented through the SBS into the offgas discharge pipe.

Cooled condensate is recycled from the SBS condensate vessel to the SBS at an approximate normal rate of 80 gpm using a SBS condensate purge pump (LOP-PMP-00001, -00004). The recycle rate is higher than that of the condensate being removed, thereby maintaining the constant liquid level necessary to control offgas flow rates in the SBS. The recycled condensate contributes to the cooling of the SBS and keeps collected solids in suspension for removal. A spare purge pump (LOP-PMP-00002, -00005) is also installed in each SBS condensate vessel.

To help remove solids, the recycle stream is pumped through eight lances that agitate the bottom of the SBS and consolidate the solids near the suction of the SBS water purge pump (LOP-PMP-00003A, -00006A). An eductor, powered by a side stream from the recycle line, is used to suspend the solids accumulated in the SBS condensate vessel.

The condensate produced, and solids captured, in the SBS are purged every 24 to 48 hours. The SBS water purge pump transfers condensate to a SBS condensate collection vessel (RLD-VSL-00005) at an approximate normal rate of 48 gpm. A spare purge pump (LOP-PMP-00003B, -00006B) is also installed in the SBS.

4.1.1.1.4 Wet Electrostatic Precipitator (WESP)

Refer to P&IDs: 24590-LAW-M6-LOP-00001004 (melter 1)
24590-LAW-M6-LOP-00002004 (melter 2)

Refer to calculation: 24590-LAW-MKC-LOP-00005
24590-LAW-M6C-RLD-00015 (RLD-VSL-00004 overflow sizing)
24590-QL-POA-MKE0-00001-07-01, -02 (pressure vessel design)
24590-QL-POA-MKE0-00001-07-03 (skirt design)
24590-LAW-ESQR-ENG-12-0090, 91 (pressure vessel skirt design calc)
24590-LAW-ESQR-ENG-12-0092 (pressure vessel skirt design)
24590-LAW-U3C-PPJ-00002 (WESP high level interlocks)
24590-QL-POA-MKE0-00001-13-01 (design, efficiency, heat, electrical 2005)
24590-LAW-N1D-LOP-00003 (vessel corrosion evaluation)

Refer to drawing: 24590-QL-POA-MKE0-00001-06-23 *Fogging Header LAW WESP*

After initial aerosol and soluble gas removal in the SBS, the cooled offgas is routed to a WESP (LOP-WESP-00001, -00002) for further removal of particulates and aerosols. Each melter system has a dedicated WESP.

The shell of the vessel is 8 ft external diameter (59 in. internal diameter) and 14.4 ft tall, not including the dished top and bottom, 21.5 ft overall. The tank tangent (T-T) line is defined as the elevation of weldment between the

bottom head and shell of the WESP vessel. Due to chloride presence and its corrosiveness the WESPs are fabricated from a 6 % Mo alloy.

The WESP performs a series of process steps. Warm, 122 °F nominal, saturated offgas enters the WESP inlet at 1280 SCFM and -49 in. WG from the passive SBS (LOP-SCB-0001). The vessel design temperature is for a maximum temperature of 170 °F and minimum of 45 °F with a normal operating 121 °F +/-15 °F. The pressure drop from the SBS is 7 mbar. This temperature is stabilized by the active cooling of the SBS by internal coils and external cooling jacket. The offgas consists of air, water, vapor and minor amounts of aerosols created by agitation of vessel contents. The incoming offgas stream enters from the side near the bottom through a 10 in. nozzle N01 at 23.5 in. above the T-T line and is dispersed and diverted downward by an angled plate. Of the diverter's 16.9 in. height, 3.5 in. are submerged during normal operations. Offgas must then pass upward through a lower perforated baffle for more even distribution of the offgas where it is met by an array of nine nozzles on three headers delivering a total continuous spray of 0.36 gpm of demineralized water, refer to details in drawing listed above. The lower level misters above the baffle plate increase efficiency of cleaning and cooling the melter offgas before it reaches the electrodes. (Inlet temperature is given as 170 °F in the design data on the General Arrangement LAW WESP drawing.)

With cooling of the offgas stream there will be concomitant condensation within the WESP. This condensation combined with added process water will increase liquid level in the base of the WESP. The level of liquid is measured by an ultrasonic/radar level transmitter (24590-LAW-JL-LOP-1059, -2059) using a stilling well, or bridle, system. The 10 in. offgas inlet nozzle is centered at 23.5 in. above the T-T line, a full 13 in. above the top of the inlet nozzle. High level liquid, and solids collection, may restrict or block the incoming offgas flow path, increasing pressure in the WESP back to the melter. This may result in a potential melter offgas release event. The liquid storage capacity, including 4 in. of straight wall above the T-T line weld of the dished head, is 657 gallons. This represents the lower limit of measurement by the stilling well.

4.1.1.1.4.1 WESP Electrodes and Power Supply (PSUP)

Block Diagram: 24590-LAW-E6-LVE-00201 (melter 1 - PSUP)
24590-LAW-E6-LVE-00202 (melter 2 - PSUP)

Refer to Drawing: 24590-QL-POA-MKE0-00001-06-28 *Collector Details LAW WESP*
24590-QL-POA-MKE0-00001-06-32 *General Arrangement LAW WESP*
24590-QL-POA-MKE0-00001-06-2 *Electrode Details LAW WESP*

The evenly distributed saturated gas now moves up through the positively charged collection electrode. The collection electrode is a large array of 123- 16 gauge 6 in. OD AL-6XN parallel stainless steel tubes welded at each end to two perforated circular support plates to create a cylindrical unit 4 ft 5.75 in. tall and 7 ft 5.5 in. diameter, which forms the precipitator collection electrode. It has three lifting lugs mounted on the top for installation and removal from the vessel. It is attached to the vessel on the upper collecting tube support plate by a flange using 20.625 in. diameter bolts and nuts around the outer edge. Both top and bottom flanges are sealed by a 0.625 in. thick EPDM gasket. The tube bundle weighs 3065 lb.

The negatively charged dispersive electrodes transfer negative charge to particles to be collected and run down the centerline axis of each collection tube. The negatively charged electrodes generate an electric field which transfers a negative charge to the particles and fine droplets which then allows them to be electrostatically collected onto the positively charged collection electrode. They are fabricated from the same AL-6XN alloy as the collector electrode and are nominally 7 ft long with eight rows of 0.625 in. tall 16-gauge spines spaced equally

around a 0.375 in. rod. Electrode edge points, 0.375 in. tall, are scallop cut out of the spines at a 0.4375 in. radius and run parallel along the rod's central 4 ft length. This middle section of electrode edge points will be the portion of the discharge electrode located inside their corresponding tubes. The edge points facilitate the creation of a controlled high voltage discharge corona inside the tubes. Care is to be taken in keeping the points clean for uniform corona creation. Each of the 123 tubes of the collection electrode has a corona-generating electrode centered in it with a maximum +/-0.25 in. deflection from the tube center. The portion of the electrode rod extending above and below the collection electrode tube is for hanging and support. The electrodes weigh 700 lb.

The whole dispersive negative electrode assembly is electrically charged during operation and must be isolated from WESP vessel walls and the positively charged electrode tube assembly. The electrode assembly is supported by four 1 in. diameter threaded rod through the 1.25 in. diameter holes in the insulators.

The accumulated fluids from the flush/wash, sprayer, and condensation are free-draining through the dished tank bottom by gravity into the collection vessel RLD-VSL-00004. The offgas will then enter the bottom of the electrostatic precipitator.

Periodic rinse is to wash down the electrodes and vessel walls with demineralized water at a rate of 100 gpm total from nine spray nozzles. Each nozzle has a 0.28 in. diameter hole and all nozzle spray patterns overlap. Some of the condensate will flow back down the sides of the tubes, be atomized, and get entrained in the offgas stream back up different WESP tubes. A 5-minute flush will generate 500 gallons of wash fluid and the storage capacity is 657 gallons.

The general arrangement LAW WESP states a < 1 in. WG pressure drop. *Flowsheet Bases, Assumptions and Requirements* (24590-WTP-RPT-PT-02-005) (BARD) states pressure drop is 6 mbar, and line pressure drop from WESP to vessel vent header is 13 mbar.

Four unglazed deeply ribbed alumina insulators 18.5 in. in length electrically isolate the high voltage dispersive electrode assembly from the grounded collection electrode tube assembly. The insulators are suspended in the centers of the spool assembly by plates. The three insulators not attached to the incoming power cable are perforated with six equally spaced 1 in. diameter holes which allow air to pass around the insulator. The power cable incoming box has no holes. The circular plates are seated then epoxied onto the insulators and a 0.125 in. EPDM gasket seals the insulator mounts to the support plate. The insulators are deeply ribbed to prevent flashover. Flashover is where current is conducted along the surface of the insulator. If material collects on the surface, a leakage of current and eventually flashover may occur, shorting the system. If the lower resistance material collected on the surface gets wet, flashover voltage can be reduced by 50 %. The orientation of the deep ribs form downward-facing, cup-shaped surfaces to help shed build-up like an umbrella sheds rain. In order to further reduce electrical losses, purge air is introduced.

Purge air for electrodes is heated to at least 5 °F above the offgas inlet temperature by LOP WESP purge air heaters (24590-ME-LOP-HTR-0001, -00002). This prevents any condensation on the main electrodes or within the electrode housings. These electrodes provide high-voltage power to the two precipitator electrodes. The BARD states 350 ACFM heated continuous purge is at 1 psig and at least 5 °F above offgas inlet temperature to maintain a dry atmosphere within the electrical insulator housing. (The BARD states air is for conductors at one point, insulation at another, and housing at a third.) Approximately 85 ACFM will go to each of the four insulator housings, and 5 ACFM to the upper electrode, which is supplying power. There are three ports where the purge air is introduced near the top of the containment ducts without electrical supply cables where it flows down and past all the ribs, through the perforated support plates, then into the WESP vessel chamber. One taller containment duct is for supply power as well as mechanical support of the high voltage electrodes and the other three provide mechanical support. Since the one for power supply has no perforated plate, purge air enters below

the insulator plate. A second purge enters just above the insulator plate and exits at the top of the weldment above the incoming high-voltage cable port. This purge vent joins with other vessel vents and connects to the LVP header ahead of the HEPA heaters.

The automated dynamic management of the electrical power control in the electrostatic precipitator is the key to its functioning. This is accomplished through switched integrated rectifiers (SIR) main units. Power and control cabinet includes monitoring equipment for WESP as well as housing the central control unit and cable terminals for the SIR. This unit also contains the converter consisting of electronic power circuits for frequency conversion of the mains. Finally there is an oil filled high frequency / high voltage transformer and rectifier.

The SIR main unit contains an internal fan for force-cooling the converter and high voltage unit. Inlet air is sucked in at the lower front, cooling the control cabinet. It is then pulled through a perforated vertical plate into the high voltage unit where it drawn through the semiconductor heat sink before it exits the outlet on the opposing side.

In the power and control cabinet the main circuit breaker handle is mounted on the cabinet door. The cable box for the incoming mains is just below the cabinet door. A connection plate for control cables is on the bottom side of the box as well. A supplemental heater is inside the cabinet to stop condensation and is activated when SIR is switched off. A number of electrical components are housed in the control cabinet. (See standard electrical drawings for SIR from operating manual). The controller is in this cabinet as well as the service connection for the RTU. Four LEDs are present.

The converter is located under the SIR cover and on the right hand side and connected to the power and control cabinet via two cable harnesses is the converter, protected by an aluminum cover. Under the cover is a rectifier, power transistor switches, and a power transistor driver board with LEDs. The LEDs can be seen through a slot in the aluminum cover.

The final major component under the SIR cover is the high voltage unit. It is surrounded by cooling vanes molded into the housing. Inside the high voltage unit is a transformer, a rectifier and an HV bushing. It contains approximately 50 liters of dielectric oil.

A number of settings must be made to the SIR in order to optimize efficiency and operation. The three phase alternating current supply power is rectified in a three phase rectifier (converted from AC to DC) and then inverted in a converter (DC back to AC) to high frequency current (25-40 kHz). This current is then transformed in the high voltage units before being rectified for use by the WESP. See block diagram. There are optional secondary controls for additional functions.

Both WESP vessel offgas outlets, along with the vessel vent, join to the LVP system ventilation header (24590-LAW-M6-LVP-00001001) which is next treated by the HEPA preheaters and two parallel HEPA filters. This header has the ability to be flushed by demineralized water which drains to vessel RLD-VSL-00004, the C3/C5 drains / sump collection vessel.

The WESP control system consists of a programmable logic controller (PLC), a local human machine interface (HMI) touch screen as well as the plant wide distributed control system (DCS). The PLC interfaces with the precipitator's high voltage transformer/rectifier (T/R) and provides status of the operating parameters to the HMI and DCS. The DCS provides remote control and monitoring of the WESP system. It also controls the purge air and electrode wash systems. The T/R must be off during a wash cycle.

4.1.1.2 The following major equipment is part of LVP

Refer to P&ID:

Refer to calculation: 24590-LAW-M6C-LVP-00003, Pipe Sizes for LAW LVP Systems
24590-LAW-M6C-LVP-00004, Offgas Pipe and Exhauster Sizing for LOP and LVP Systems
24590-LAW-M6C-LVP-00006 (overpressure protection eval),
24590-LAW-M6C-LVP-00008 (pressure rupture disc spec)
24590-LAW-MEC-LVP-00003 (design LVP pressure and temperature calc)
24590-LAW-MEE-LVP-00004 (update LVP pressure and temperature calc)

4.1.1.2.1 High Efficiency Particulate Air (HEPA) Filter Electric Preheater

Refer to P&ID: 24590-LAW-M6-LVP-00001002

Refer to calculation: 24590-LAW-M6C-LVP-00012
24590-LAW-M6C-LVP-00028

Refer to datasheet: 24590-LAW M0Q-LVP-00002, Equipment Qualification Datasheet for LVP HEPA Preheaters

The combined offgas stream is split and each stream is passed through one of two parallel normal process offgas heaters (LVP-HTR-00001A or LVP-HTR-00003A). These normal process offgas heaters utilize electric heating elements to increase the gas temperature of the combined offgas stream at least 18 °F from a nominal 131 °F to 149 °F to decrease relative humidity of the offgas and prevent condensation in downstream components, particularly the HEPA filters. Sizing of these heaters is such that if one of them fails, the other unit can maintain the combined stream offgas required temperature increase. The normal heaters have a duty of 75 kW non-safety. In addition to these normal process heaters, there are safety heaters (LVP-HTR-00001B and LVP-HTR-00003B) that are installed in series, one series with each process heater. Each of the Safety heaters are made up of 3 × 13 kW heater elements (39 kW total per Safety heater). Each of these elements can be turned on individually by PPJ as needed to maintain the required combined stream offgas differential temperature. These Safety heaters are only activated in the event that the normal process heaters fail to maintain the requisite combined stream temperature, or can be operated with UPS, same units as exhausters, in the event of a loss of normal power.

4.1.1.2.2 HEPA Filters

Refer to P&ID: 24590-LAW-M6-LVP-00001003

Refer to calculation: 24590-QL-POA-MKH0-00001-18-00004 (Flanders HEPA structural analysis)
24590-QL-POA-MKH0-00001-18-00005 (Flanders HEPA structural analysis)
24590-RMCD-02782 (Flanders LVP HEPA structural analysis)
24590-RMCD-02877 (Flanders LVP HEPA structural analysis)

The HEPA filters provide the final removal of radioactive particulates to protect downstream equipment from contamination.

The heated offgas passes through HEPA filter housings forming two trains: a main train (LVP-HEPA-00002A/-00001A, operated in parallel, followed by -00003A) used in normal operations; and an auxiliary train (LVP-HEPA-00001B, followed by -00002B) used as an installed back-up. The HEPA filter housings in each train are arranged to form primary and secondary stages of filtration. Each stage contains a set of four HEPA filters with a total rated capacity of 8000 ACFM. Each HEPA filter has a rated capacity of 2000 ACFM.

The HEPA filters and housings have been qualified by ASME AG-1 at 100 % and 20 % of rated capacity. Therefore, each stage of HEPA filters must operate between 8000 ACFM and 1600 ACFM (i.e., 20 % of 8000 ACFM) to meet the ASME AG-1 requirement.

To accomplish the minimum AG-1 flow when only one melter is operating, the airflows at the WESP and the film cooler for the operating melter may be increased. The additional airflow required is estimated to be 100 ACFM from these combined sources.

4.1.1.2.3 Activated Carbon Mercury Adsorber Skid and Bypass

Refer to P&IDs: 24590-LAW-M6-LVP-00004001
24590-LAW-M6-LVP-00004002
24590-LAW-M6-LVP-00004003

Refer to datasheet: 24590-LAW-MVD-LVP-00003

Equipment Description. After flowing through the LVP HEPA filters, the offgas flows through two activated carbon bed adsorber units. The purpose of the carbon bed adsorber units is to remove volatile mercury compounds, acid gases (e.g., HCl, HF), and I-129 from the offgas stream to reduce stack air emissions. The adsorber bed units are positioned upstream of the catalytic oxidizer/reducer skid (LVP-SKID-00002) to remove compounds (primarily halides and Hg) that could poison the catalysts and adversely affect the performance of the selective catalytic oxidizer and reducer.

The absorber units are closed rectangular vessels (Unit A and Unit B). Each of the vessels is approximately 20 ft long, 10 ft high and 8 ft wide, not including the structural steel base frame. Each adsorber unit consists of an inlet plenum, a primary adsorber bed, a secondary or guard bed, and an outlet plenum. The adsorber units are normally operated in-series. The bottom of each vessel is designed with six hoppers where the adsorption media is unloaded when necessary. Fill ports normally closed by blind flange are provided in the top of the vessels for loading in fresh adsorber media.

The primary bed is a mixed product composed of zeolite and sulfur-impregnated cylindrically shaped activated carbon. This media is designed for high selective removal of Hg. It has a total surface area of $800 m^2/g$ and an approximate diameter of 4mm. The secondary guard bed is a soda lime (3 % NaOH and 75% $Ca(OH)_2$) adsorbent media designed for the removal of acid gas contaminants (primarily HCl and HF).

The LAW melter offgas flows into an inlet plenum at one end of the adsorber unit. The gas then flows into air slots on one side of the unit, between the side wall and the primary bed. The gas flows through the primary bed then through the guard bed, exiting into air slots against the opposite wall of the unit. The gas flows out of the air slots and into the outlet plenum. The offgas passes through a set of fiberglass discharge filters located in the outlet plenum before discharge into the outlet duct (18 in. process pipe). The adsorber vessels and associated piping are fabricated from 316L stainless steel.

Operated in series, the adsorber units are designed to obtain a mercury decontamination factor of $\geq$450. The mercury concentration in the offgas is reduced to <45 ug/m^3 (with volumetric flow corrected to standard conditions). The adsorbers have a removal efficiency for HCl or HF of $\geq$ 97 % and a removal efficiency for I_2 of $\geq$ 99 %. (Reference: 24590-LAW-MVD-LVP-00003)

The adsorber vessels are designed to withstand full vacuum and are required to withstand a positive pressure of at least 4 psig (design pressure to be determined by seller). A pressure relief path with rupture disk is provided on each adsorber vessel. The pressure relief path vents back to the offgas header. The carbon adsorber design temperature of 300 °F accounts for exothermic reactions within the carbon beds. This provides a contingency of 138 °F above the maximum gas inlet temperature.

Significant instrumentation associated with the carbon bed adsorbers include pressure and temperature transmitters, carbon oxide (CO_x) monitors, and monitors for mercury, HCl and HF. Pressure transmitters are installed on the inlet and outlet pipes from the adsorber beds. These are used to track pressure drop across the skid. Excessive pressure drop causes the skid bypass valve to be opened by interlock. Differential pressure (DP) monitoring across the discharge filters monitors buildup on the filters and provides indication for changing out the filters. Temperature transmitters on the inlet and outlet piping from the carbon bed adsorbers are used to track offgas temperature and to monitor offgas temperature increase from exothermic reactions in the beds. In addition, four thermocouples are provided in drywells that extend down into the adsorber beds. These allow bed temperature to be monitored.

Carbon oxides (CO_x) monitors are provided on the inlet and outlet piping to the carbon bed adsorbers. These monitor both CO and CO_2 in the offgas stream. High differential CO_x across the adsorbers is used to detect an accidental combustion condition in the carbon beds. An Hg monitor is connected by piping to the discharge plenums of both adsorber vessels. Valves are used to draw offgas from either plenum through the Hg monitor back to the offgas header. This monitor is used to verify acceptable mercury loading in the treated offgas and to detect bed breakthrough. HF and HCl monitors are located on the discharge line from the skid. These monitors serve an air permit function.

Piping arrangement allows for either bed to be valved-in as the lead bed. A bypass path is also provided around the carbon beds. Butterfly valves on the inlet and outlet pipes from both vessels are used to line up the beds in lead/lag position or to isolate the beds for media change out, maintenance activities, or to respond to various safety trips. The bypass valve is opened to maintain vacuum and offgas flow through the offgas system when the vessels are isolated.

The bypass valve and isolation valves are designated SS to ensure reliable function in various postulated accident scenarios. The butterfly valves are air actuated. The inlet and outlet valves on each adsorber vessel are normally-open/fail-closed (NO/FC). The bypass valve around the skid is normally-closed/fail-open (NC/FO). Solenoids valves are used to apply or vent air to/from the valve actuators. The valves are dual purpose, meaning they are used to isolate and bypass the beds for both normal maintenance activities (such as adsorbent media change out or discharge filter replacement) and to respond to various accident conditions. Instrument air is provided through two solenoid valves, in-series, to the actuator. The first solenoid valve is controlled by the integrated control network (ICN) system. The second solenoid valve, closer to the actuator, is controlled by the PPJ (Safety control) system. To actuate the valve from the fail position, both solenoid valves have to be lined up to supply air to the actuator. The PPJ controlled solenoid valve is powered to line up and allow normal and maintenance operation. When this valve is deactivated the butterfly valve will vent to the fail safe condition. This allows the PPJ system to isolate and/or bypass the adsorber vessels independent of the ICN signal. Otherwise the ICN controlled solenoid valve will actuate or vent the butterfly valve actuator so the valve will control to the proper position during normal and maintenance operations.

Media and Discharge Filter Change Out. Activated carbon life is expected to be approximately two years. Hg breakthrough is monitored using the Hg monitor connected to the discharge plenums of both adsorber units. The carbon adsorber vessel is bypassed and the inlet and outlet butterfly valves are closed during media change out. The spent carbon media is discharged through slide gates, and hoppers on the bottom of the vessel. The media is gravity-drained into drums. A portable fan and HEPA filter unit is connected to the discharge plenum (via a discharge filter access panel) to maintain the adsorber unit under vacuum and to control dust during media change out operations. The guard bed soda lime media is removed from the unit in a similar fashion. There are three withdrawal ports and hoppers on the bottom of the vessel for each bed. The base frame of the adsorber vessel is tented with plastic sheeting and the drum liner is secured to the slide gate to minimize contamination spread during the unloading process.

Fresh media for both the primary and guard beds is loaded through ports provided on the top of each vessel. Blind flanges are removed as necessary from each port to add the adsorber media. The media is loaded from sacks using a hoist into a filling table. The filling table directs the media into a hopper assembly. The hopper assembly is then repositioned by hoist to the desired fill port. There are five filling ports for the primary bed and five filling ports for the guard bed. A concrete vibrator is installed and operated in the current port after each batch of media is added and is then inserted and operated in an adjacent port to aid in settling of the media. The process is repeated in the remaining ports until the bed is full. The gaskets on the fill port flanges are replaced before re-installing the blind flanges to re-establish the confinement boundary of the vessel.

Access to the discharge filter elements for change-out is accomplished through panels located on the wall of the discharge plenum. The filters are replaced based on high differential pressure (DP) measured across the discharge filter bank. A bag-out/bag-in procedure is used to prevent contamination spread during filter change out.

4.1.1.2.4 SCO / SCR Skid

Refer to P&IDs: 24590-LAW-M6-LVP-00005002

Refer to calculation: 24590-CD-POC-MBT0-00007-02-00001 (mass/energy balance)

Refer to datasheets: 24590-CD-POC-MBT0-00007-03-00001 (mechanical - redox),
24590-CD-POC-MBT0-00007-03-00011 to -00037 (controls, valves, filters)

List of instruments: 24590-CD-POC-MBT0-00007-09-00001

Ionex has provided for skid components through a series of purchase orders 24590-CD-POC-MBT0-00007-08-00001 to -00017.

4.1.1.2.5 Recuperative Heat Exchanger

Refer to P&IDs: 24590-CD-POC-MBT0-00007-02-00001 (mass-energy SCO-NH_3 skid)
24590-LAW-M6-LVP-00004001 (bypass),
24590-LAW-M6-LVP-00004002 (skid), and
24590-LAW-M6-LOP-00004003 (adsorber 1A/B)

Refer to calculation:

Refer to datasheets: 24590-CD-POC-MBT0-00007-03-00008 (exchanger core)

The recuperative heat exchanger raises the offgas temperature using the hot offgas from the catalyst beds. Design flow on the cool inlet side is 5,403 cfm and 13,096 lb/hr at 189 °F with a pressure drop of 0.98 in. WG from the warm side inlet design flow is 13,805 cfm and 16,673 lb/hr at 805 °F with a pressure drop of 1.53 in. WG. The heat exchanger has a design temperature of 850 °F and a maximum heat transfer of 1,752,000 Btu/hr for an 82.7 % thermal transfer effectiveness.

4.1.1.2.6 Electric Heater

Refer to datasheets: 24590-CD-POC-MBT0-00007-03-00009 (law SCO)

The downstream electric heater is used to supplement the heat recovery exchanger primarily during startup and when operating with low NO_x concentrations. It acts as a trim control to raise the offgas temperature to the desired oxidation temperature. The heater contains thermal monitoring instruments and active electrical controls. It is composed of five blocks mounted to a duct weldment. The duty of the 480VAC Incoloy-800 heater is 310 kW. It has a normal operating temperature of 750 °F and a maximum and design limit temperatures of 805 °F and 850 °F respectively.

4.1.1.2.7 SCO Catalyst

Refer to datasheet: 24590-LAW-MKD-LVP-00012
24590-CD-POC-MBT0-00007-03-00003 (SCO catalyst)

Volatile organic compounds (VOC) are also present in the offgas stream. Environmental air emissions requirements for both NO_x and VOCs require their reduction or removal from the offgas stream before discharge through the stack.

The heated offgas is passed through the VOC catalyst in the selective catalytic oxidizer (LVP-SCO-00001) to oxidize VOCs and carbon monoxide to water vapor and carbon dioxide. The VOC catalyst is a platinum-based material deposited on a cordierite ceramic monolith. Cordierite is a common catalyst substrate due to its high thermal shock resistance, good strength and low thermal mass. The units are held in frames and inserted/removed through access doors. The VOC catalyst is designed to achieve a VOC DRE of 95 %.

4.1.1.2.8 Ammonia / Air Dilution Skid

Refer to P&IDs: 24590-LAW-M6-LVP-00005001

Refer to calculation: 24590-CD-POC-MBT0-00007-02-00001 (mass-energy balance)

Refer to datasheets: none available

The offgas has high levels of NO_x because the melter decomposes the parent nitrate/nitrite compounds. Some of the resultant NO_x is decomposed to nitrogen and water in the melter, and some is removed by scrubbing in the SBS. After the offgas passes through the SCO unit it is then injected with a mixture of ammonia vapor and C3 air supplied from an ammonia/air dilution skid (LVP-SKID-00003) using ammonia dilution fans (LVP-FAN-00001, LVP-FAN-00002). The ammonia/NO_x molar injection ratio is 1:1 with a maximum ammonia consumption rate of 123 lb/hr. Instrumentation is located at the inlet and outlet of the unit to determine the NO_x concentrations and at the outlet to determine the ammonia and VOC concentrations. A control valve regulates the supply of the

ammonia to the SCR catalyst based on either NO_x or ammonia levels in the exit gas. The ammonia flow rate is maintained below a predetermined setpoint by the orifice size for the pressure regulator on the ammonia supply. The maximum ammonia slip concentration is 20 ppm. Areas containing ammonia lines are monitored to detect leaks.

4.1.1.2.9 Selective Catalytic Reducer (SCR)

Refer to datasheet: 24590-CD-POC-MBT0-00007-03-00004 (SCR catalyst)

Following ammonia injection, the offgas is passed through the SCR catalyst to reduce NO_x to nitrogen and water vapor. The SCR catalyst is vanadia / titania coatings on a ceramic cordierite monolith, which is held in frames and inserted/removed through access doors. The SCR catalyst is designed to achieve a NO_x reduction of 98 %. This is a passive system with no associated mechanical or electrical controls.

Possible catalyst poisons for both the VOC and SCR catalysts include mercury, SO_x, and halogens. Because this is one of the last treatment steps in the offgas system, other poisons are not a concern.

4.1.1.2.10 Caustic Scrubber

Refer to P&IDs: 24590-LAW-M6-LVP-00002002 (SCB),
24590-LAW-M6-LOP-00002001 (bypass),
24590-LAW-M6-LOP-00002003 (tank),
24590-LAW-M6-LOP-00002004 (recirc loop), and
24590-LAW-M6-LOP-00002005 (transfer pump)

Refer to calculation: 24590-QL-POA-MKAS-00003-06-00001 (scrubber process)
24590-QL-POA-MKAS-00003-07-00005 (ASME code)
24590-LAW-M6C-LOP-00001 (overflow drain line sizing – both),
24590-LAW-M6C-LOP-00004 (line sizing), and
24590-LAW-M6C-LOP-00006 (overflow sizing)
24590-LAW-MVC-LVP-00001 (sizing caustic collection tank)

A caustic scrubber (LVP-SCB-00001) further treats the offgas by removing acid gases (i.e., 97 % removal efficiency for combined SO_2 and SO_3) and providing cooling. This scrubber has a nominal offgas inlet flowrate of 9670 ACFM at 550 °F and 11 in. WG. The scrubber is fabricated from 316L stainless steel with the interior from Alloy 600 or 316L stainless steel with Alloy 600 cladding; see corrosion evaluation 24590-LAW-N1D-LVP-00001. The scrubber is located in room L-0304F at the 48-foot elevation.

The offgas stream enters near the bottom of the scrubber and flows upward through a packed bed. The offgas flows countercurrent to the scrub solution, which is introduced through a distributor above the packed bed and flows downward through the packing media. Contaminants in the offgas stream are absorbed into the liquid.

The hot offgas stream entering the bottom of the scrubber is cooled by evaporation of a portion of the quench water sprayed into the bottom of the column to enhance gas absorption in the packed section. The degree of cooling and offgas temperature attainable at the bottom of the packing are limited by the quantity of water that can be evaporated before the offgas stream becomes saturated with water vapor. There is no other source for cooling for the recirculating buffer stream in the LVP scrubber system. The temperature of the buffer solution in

the tank depends on the efficiency of the evaporative cooling of the hot offgas stream by the quench water sprays. Because the gas stream discharged from the scrubber will be saturated and in thermal equilibrium with the recirculating solution supplied to the top of the packing, the scrubber gas outlet temperature depends on the temperature of the buffer solution contained in LVP-TK-00001.

There are four individual spray nozzle assemblies located in the bottom of the scrubber. To provide the extremely small droplet size required for instant evaporation, the water stream is atomized by a small amount of compressed air. The pressures and flow rates of quench water and atomizing air to the quench water spray nozzles are critical to efficient cooling of the offgas at the scrubber inlet and are therefore carefully controlled.

The packing is designed to enhance the absorption of the acid gases from the offgas stream into the buffer solution. To enhance gas absorption, the packing provides a large surface contact area in a small height of the scrubber where the small passages through the packing force intimate contact between the rising cooled offgas stream and the buffer solution flowing down through the packing.

Flooding of the packing can occur (high DP) when either the incoming offgas or the flow rate of the recirculated buffer solution is too high. The flow rate of the recirculated buffer solution is controlled to prevent flooding.

The eight packing bottom water sprays are used to wash solids from the bottom portion of the packing weekly or more often if the packing DP instrumentation indicates a higher than normal DP.

The scrubbed offgas is then passed through a mist eliminator. Evaporation of the scrub solution cools the offgas before exiting the scrubber. While liquid droplets of 10 microns size are easily removed by impaction, droplets below 3 microns follow the gas flow around the impaction surfaces. The four demister towers are designed to remove the small (< 3 micron) droplets through Brownian motion, which requires the gas to be maintained in close proximity to the filter element for as long possible. The filter towers have a large flow area and the gas flow face velocity of < 1 ft per second.

The scrub solution drains into a caustic collection tank (LVP-TK-00001). This liquid is recirculated to the top of the scrubber using a caustic scrub solution recirculation pump (LVP-PMP-00003A/B). The two pumps are rated at 200 gpm each and are intended for one pump to be in operation while the standby pump is for backup in case of pump failure or maintenance. The recirculation pump supplies fresh buffer solution on the top of the packing for acid gas absorption.

The four demister spray nozzles are aimed directly at the top inner surface of each element to wash any surface accumulation from the elements to reduce the DP. The flushes will be performed periodically and when the DP has been seen to increase. Because the elements are depth filters, small droplet capture may occur deep within the media where a solids accumulation may not be reached by the surface sprays. If this occurs, causing the DP to continue to rise, the elements must be removed and replaced.

The scrubber drain piping is 8 inches from the bottom of the scrubber and routes the scrubber solutions to the top of the caustic collection tank. The drain piping has a long, near-horizontal, 16-inch pipe section that provides a liquid volume in the drain, which will maintain a liquid hydraulic seal between the scrubber operating under vacuum and the caustic collection tank that operates at atmospheric pressure.

The caustic collection tank collects three solutions of slightly different pH and provides a holdup volume where the recirculation of buffer solutions is relied on to mix the three solutions: 1) The buffer solution pumped at about 200 gpm from the bottom of the caustic collection tank for recirculation back to the top of the packing is maintained within the design pH range. 2) The buffer solution recirculated to the top of the packing drains from the bottom of the packing and then partially depleted by chemical reaction with the acid from the absorbed gases. This partially depleted buffer solution then drains at about 200 gpm out of the scrubber drain and into the top of the caustic collection tank. 3) The third solution is pumped from the bottom of the caustic collection tank at 120 gpm with the 5 molar sodium hydroxide solution continuously added to the pump suction. This solution is

routed directly to the top of the caustic collection tank. The sodium hydroxide added restores the partially depleted buffer to the initial pH.

The caustic collection tank is designed for a 2-day hold-up of accumulated caustic scrub solution. The batch volume of this tank is 7,750 gal. The tank is 13 ft in diameter by 14 ft, 4 in. high (to the upper tangent) with a maximum operating volume of 11,920 gal. This tank is fabricated from 316 stainless steel; see corrosion evaluation 24590-LAW-N1D-LVP-00002.

The tank buffer solution volume is maintained to support the recirculation of buffer solution to the top of the packing in the scrubber. The tank is fitted with level instrumentation. Sampling capability and measurement of density, temperature, and flow are provided at the discharge of the recirculation pumps. The tank vent is routed to inside the C2V system exhaust intake for room L-0218 to prevent potential personnel exposure to fumes. The caustic collection tank overflows within the surrounding berm.

A caustic blowdown transfer pump (LVP-PMP-00002A/B) normally recirculates the scrub solution back to the caustic collection tank. To neutralize the acid gases collected in the caustic collection tank, 5 molar sodium hydroxide is continuously added to the caustic blowdown transfer pump suction pipe as it pumps buffer solution from the bottom of the caustic collection tank. The solution is returned to the top of the tank at about 120 gpm. The recirculation pumps supply fresh buffer solution on the top of the packing for acid gas absorption. The flow rate is controlled at a constant value at which a packing flood cannot occur. The recirculation pumps are rated at 120 gpm each and are intended for one pump to be in operation while the standby pump is for backup in case of pump failure or maintenance. The caustic blown-down pump has two functions; continuous recirculation of the caustic collection solution to enhance buffer mixing because the tank has no agitator, and to periodically pump excess solution out of the tank to the RLD system. Supply fresh buffer solution on the top of the packing for acid gas absorption. The flow rate is controlled at a constant value at which a packing flood cannot occur.

The caustic scrubber is designed to operate in the pH range of 9.5 to 10, which brackets the pH of equal portions of Na_2CO_3 and $NaHCO_3$ salts in solution. Operation within the 9.5 to 10 pH range minimizes the quantity of carbon dioxide absorbed from the offgas stream and operation above a pH of 10.3 can significantly increase the quantity of carbon dioxide absorbed, which would increase the carbonate salts in the buffer solution. The pH of the buffer solution is determined by the $Na_2CO_3/NaHCO_3$ molar ratio. While carbonate salt is being depleted by chemical reaction with absorbed acids, additional carbonate salt is being generated from carbon dioxide absorption. Five molar sodium hydroxide is continuously added to the 120 gpm of buffer solution pumped from the bottom of the caustic collection tank and returned to the top of the tank. NaOH is added to the caustic collection tank to reverse the reaction by reacting with $NaHCO_3$ to reform Na_2CO_3, which restores the full buffering capacity of the solution. Restoring the buffer solution capacity also restores the original solution $Na_2CO_3/NaHCO_3$ molar ratio and pH prior to recirculation back to the top of the packed section. Once the functional buffer solution is established (sufficient concentrations of both sodium carbonate and sodium bicarbonate to maintain the solution pH near constant from the top of the packing to the bottom of the packing), normal operation will maintain the functional buffer solution because of the continuous absorption of more carbon dioxide. The pH of the buffer solution is determined by the $Na_2CO_3/NaHCO_3$ molar ratio. The caustic reacts with sodium carbonate in the buffer solution, converting sodium carbonate to sodium bicarbonate to restore the sodium carbonate/sodium bicarbonate mole ratio, which restores the original pH.

As long as the scrubber solution is maintained within the design range of 9.5 to 10, there will be no salt precipitation from the buffer solution salts. If the buffer solution pH is maintained significantly above 10, then more than 1.7 % of the carbon dioxide will be absorbed, which would be above the scrubber design value. Above a pH of 10.8, all of the sodium bicarbonate has been converted to sodium carbonate and there is no longer any pH buffering. That is, the pH change will rapidly increase as additional sodium hydroxide is added to the solution.

The 1.7 % carbon dioxide absorption is from a proprietary calculation by the packing vendor. Although it is well known that as the solution pH rises above 10, no reliable carbon dioxide absorption values were found for solution pH values above 10. The 1.7 % carbon dioxide absorption requires 98 % of the total sodium hydroxide demand for scrubber operation. Therefore, operation with solution pH values above 10 would significantly increase the buffer solution carbonate salt concentrations.

Calculations show that the salt content of the buffer will rise during normal operation, and then level off at a maximum value unique to the sodium hydroxide demand for neutralization of the acid gases absorbed from the offgas stream. For operation of the solution at the design pH values of 9.5 to 10, the equilibrium values for sodium carbonate salt concentrations will be well below the solubility of both sodium carbonate and sodium bicarbonate. The carbonate concentration values reach a an equilibrium maximum limit due to the dilution of the buffer solution by excess quench water and the removal of carbonates from the system when the buffer solution is periodically pumped to RLD to maintain the solution volume in the Caustic Collection Tank within limits.

The buffer solution pH is measured at the recirculation pump suction from the bottom of the caustic collection tank for recirculation to the top of the packing to provide guidance on the 5 molar sodium hydroxide rate adjustments. The pH values determined by the pH system are used to determine if the continuous 5 molar sodium hydroxide addition rate is adequate and if not, whether the rate should be increased or decreased. For pH values trending down, the rate will be increased and for pH values trending upward, the rate will be reduced. To control 316L stainless steel corrosion rates, the scrubber's reagent pH can be raised to a pH of 14 for a predetermined duration when high halides are measured in the scrubber bottoms. Chloride and fluoride analytes are monitored at sample point PT-35 from the PT alkaline effluent vessels (RLD-VSL-00017A/B) to determine when the scrubber's reagent pH should be raised to control corrosion rates (monitoring point only, not a hold point).

The scrubber drain piping is 8 inches from the bottom of the scrubber and routes the scrubber solutions to the top of the caustic collection tank. The drain piping has a long, near-horizontal 16-inch pipe section that provides a liquid volume in the drain that will maintain a liquid hydraulic seal between the scrubber operating under vacuum and the caustic collection tank that operates at atmospheric pressure.

Hydraulic seal failure (i.e., seal loop not full of solution) would allow air in-leakage with a loss of vacuum being detected. (Normally, once the seal is filled it will remain functional from that point on. During operation, about 200 gpm of solution continuously passes through the seal loop and drains into the caustic collection tank. There is a drain pipe and valve at the bottom of the seal loop that can be opened to drain the loop. Re-fill of the loop would be performed via the various sprays in the caustic scrubber.)

Periodically, the scrub solution is discharged to a PT Facility alkaline effluent vessel (RLD-VSL-00017A/B). When this transfer is required, the caustic addition is terminated, the valve in the recirculation line is closed, and the valve on the transfer line is opened. After the transfer, the interfacility line is flushed.

There is a dedicated interfacility line draining back from the LAW Facility to each RLD vessel. The material of construction for the pipes is 316L stainless steel. The transfer lines are each encased with an outer carbon steel pipe that drains to a leak detection box located in the PT Facility. The outer pipe has a hose connection so it can be flushed from the LVP system to the leak detection box.

Process water is added directly to the tank at a rate sufficient to maintain the specific gravity of the scrub solution below a maximum of 10 wt% dissolved solids. Suspended solids are not expected in the scrub solution.

The scrubber has provisions for process water addition during startup and to provide makeup water as necessary. A spray wash nozzle is also provided for washdown during maintenance periods.

4.1.1.2.11 Exhausters

Refer to P&IDs: 24590-LAW-M6-LVP-00001004 (LVP-EXHR-00001A),
24590-LAW-M6-LVP-00001005 (LVP-EXHR-00001B), and
24590-LAW-M6-LVP-00001006 (LVP-EXHR-00001C)

Refer to calculation: 24590-LAW-M6C-LVP-00004 (Offgas Pipe and Exhauster Sizing for LOP and LVP Systems)

Refer to datasheet: 24590-LAW-MAD-LVP-00006

Three multi-stage centrifugal blowers (LVP-EXHR-00001A/B/C) with adjustable speed drives (ASD) are located downstream of the caustic scrubber (LVP-SCB-00001). The purpose of the exhausters is to provide the motive force to draw the melter offgas and vessel ventilation streams, under vacuum, through the abatement processes of the offgas system and to expel the treated offgas through the stack.

The three exhausters are arranged in parallel, with each exhauster sized to exhaust 50 % of the offgas system flow. Two exhausters will normally be running at a time with the third exhauster in standby. Each exhauster train has a discharge check valve, providing backflow prevention to preclude a recirculation loop through the standby exhauster. If one exhauster should fail, the standby exhauster is automatically started. If the standby exhauster fails to start, the single remaining online exhauster is sized to maintain depression in both melters. The LVP header low vacuum interlock may bypass treatment units, shut off feed to the melters, isolate ammonia and air to the ammonia/air dilution skid, and close the vessel vent header pressure control valve as needed to accommodate single fan operation. Offgas system safety controls are described in more detail in Section 4.1.6.

The exhausters maintain the offgas piping, valves, and abatement equipment upstream of the exhausters under vacuum and are an integral part of the control strategy to maintain the melters under vacuum. The vacuum maintained by the exhausters prevents potential fugitive emissions from the offgas stream into occupied areas of the plant adjacent to the offgas equipment. In the event leaks develop through valve packing or equipment seals upstream from the exhausters, the vacuum in the system will cause in-leakage, maintaining confinement of the offgas stream.

The exhausters work in conjunction with the film cooler injection air and the flow control valves downstream from each WESP to maintain proper vacuum on the melters. The exhauster ASDs are connected to a pressure transducer (PT-0071) located at the inlet of the HEPA preheaters. The offgas flows from both melter trains, and the ventilation flow from the process vessel vent header combine upstream of this point. There is a separate controller for each exhauster. See P&ID 24590-LAW-J3-LUP-01002. The vacuum reading at the HEPA preheater inlet is used to automatically adjust the exhauster by a controller to a setpoint value calculated to be sufficient to draw offgas from the melter through the head of liquid in the SBS and through the WESP while maintaining the melter at the desired vacuum relative to the melter annulus and C5 system. The automatic speed adjustment is overridden as necessary by three PPJ interlocks. The loss of power reconfiguration interlock, the low vacuum header interlock, and the excessive header vacuum reconfiguration interlock, automatically trip all three exhauster ASDs to a predetermined speed setpoint.

Exhauster shaft seals on the pressurized side of the exhausters are provided with purge air to prevent potential exfiltration of offgas. To protect against a loss of normal purge air flow, a backup bottled air supply is provided. On detection of low pressure in the normal plant air supply to the exhauster seals, an interlock opens an isolation

valve on the bottled air supply and closes an isolation valve on the normal plant air supply to the shaft seals. The backup bottled air supply is sufficient to provide purge air to the shaft seals for 2 hours.

The exhauster design and operating conditions are provided in the datasheet (24590-LAW-MAD-LVP-00006). The exhausters are designed to provide flow rates ranging from a minimum of 1550 ACFM (per exhauster) at an inlet pressure of -78 in WG, up to a maximum design flow rate of 4760 ACFM (per exhauster), at an inlet design pressure of -163 in WG. The design maximum exhauster inlet temperature is 250 °F, compared to a normal inlet temperature estimated to range from 107 °F to 120 °F. The exhausters are designed for a maximum expected discharge temperature of 450 °F. This is well above the discharge temperature of 290 °F calculated for the maximum design condition.

The exhausters are designated as safety significant to reliably provide their confinement function. The exhausters are designed to withstand the SC-III level earthquake and continue operating. The exhausters are connected to a safety significant power supply (provided by a battery-powered UPS system). On detection of the loss of the normal power feed, the UPS battery power is switched on automatically by the safety interlock. The UPS system is sized to operate all three exhausters at a set speed for 2 hours, which is long enough to allow for cold cap burn off in the melters.

Each exhauster and associated ASD is located in a separate fire zone, protected by fire barriers, to prevent a single fire from propagating and failing multiple exhausters. The exhauster rooms are each provided with a safety significant air cooling unit to compensate for the heat load given off by the exhauster and motor.

4.1.1.2.12 Vessel Vent Process System

Refer to P&IDs: 24590-LAW-M6-LVP-00001001
24590-LAW-M6-LOP-00002001
24590-LAW-M6-LOP-00003001

Refer to calculation: 24590-LAW-M6C-LVP-00004

The vessel vent header provides ventilation to all the LOP system vessels and ties into the primary offgas piping just before the HEPA preheaters. The purpose is to maintain confinement by keeping system under slight vacuum during processing of material through the associated vessels and treat the gases through the LVP. A minimum flow of purge air is introduced to each vessel to keep their atmospheres below flammable limits. The main 8 in. line contains a 4 in. pressure control valve. A 4 in. bypass line around the valve contains an orifice (LVP-RO-00001) which will maintain a minimum flow even during complete closure or isolation of the main valve for maintenance.

After the vessel vent header and the two primary offgas lines combine into an 18 in. line, there are two safety interlocks, one for pressure and one for loss of power. The pressure limit actuates on excessive pressure or vacuum to close the pressure control valve.

LOP Interfacing Systems

Systems interfacing with the LOP and LVP systems are listed in Table 4-1 and Table 4-2, respectively.

Table 4-1 LOP Interfacing Systems

System Locator	System Name	Nature of Interface
CHW	Chilled water	SBS cooling jackets and coils receive chilled water.
DIW	Demineralized water	Primary and standby offgas film coolers, SBSs, SBS condensate vessels, SBS condensate purge pumps, WESPs flush and misters, and valve bulges receive demineralized water.
ISA	Instrument service air	Valve actuators receive air.
LMP	LAW melter process	Primary and standby offgas film coolers receive melter offgas.
LVE	Low voltage electrical	SBS water purge pumps, SBS condensate purge pumps, WESPs, and solenoid valves receive low voltage power.
LVP	LAW secondary offgas/vessel vent process	WESPs supply primary offgas.
PCJ	Process control	Components without active safety instrumented functions receive control signals.
PPJ	Programmable protection	Components with active safety instrumented functions receive control signals.
PSA	Plant service air	Primary and standby offgas film coolers, and WESP purge air heaters receive plant service air.
RLD	Radioactive liquid waste disposal	SBS water purge pumps, SBS condensate purge pumps, and WESPs supply condensate. Valve bulges supply drains.
RWH	Radioactive solid waste handling	SBSs, SBS condensate vessels, and WESPs supply equipment for removal and packaging (maintenance only).

Table 4-2 LVP Interfacing Systems

System Locator	System Name	Nature of Interface
AMR	Ammonia reagent	Ammonia/air dilution skid receives ammonia.
C3V	C3 ventilation	Ammonia/air dilution skid receives C3 air.
DEP (EMF)	DFLAW effluent management facility	Vessel vent flush, caustic effluent and SBS condensate collection (DFLAW configuration).
DIW	Demineralized water	Vessel vent header receives flush water.
ISA	Instrument service air	Instrumentation and valve actuators receive air.
LCP	LAW concentrate receipt process	Vessel vent header receives vessel vents.
LFP	LAW melter feed process	Vessel vent header receives vessel vents.
LOP	LAW primary offgas process	HEPA filter preheaters receive primary offgas.
LVE	Low voltage electrical	Catalytic oxidizer electric heater, ammonia dilution fans, caustic scrubber recirculation pumps, caustic blowdown transfer pumps, and solenoid valves receive low voltage power.
PCJ	Process control	Components without active safety instrumented functions receive control signals.
PPJ	Programmable protection	Components with active safety instrumented functions receive control signals.

Table 4-2 LVP Interfacing Systems

System Locator	System Name	Nature of Interface
PSW	Process service water	Treatment/disposal of caustic scrubber effluents. Plant wash water for rinse/decontamination and flushing.
PSA	Plant service air	Off-gas treatment components receive plant service air (e.g. damper motive power). Normal exhauster shaft seal air.
RLD	Radioactive liquid waste disposal	Vessel vent header receives vessel vents and supplies drains. Berm surrounding caustic collection tank supplies drains.
RWH	Radioactive solid waste handling	HEPA filters, mercury adsorbers, and catalytic oxidizer/reducer supply spent filter media, activated carbon media, VOC catalyst, and SCR catalyst for removal and packaging (maintenance only).
SDJ	Stack discharge monitoring	Monitors stack exhaust in conformance with permit requirements.
SHR	Sodium hydroxide reagent	Sodium hydroxide is added to the caustic blowdown transfer pump to neutralize the acid gases.
UPE	Uninterruptible power electrical	HEPA filter preheaters and exhausters receive uninterruptible power.

4.1.2 Boundaries and Interfaces

This section is currently reserved and will be updated in a later phase after work to support this section is complete.

4.1.3 Physical Layout and Location

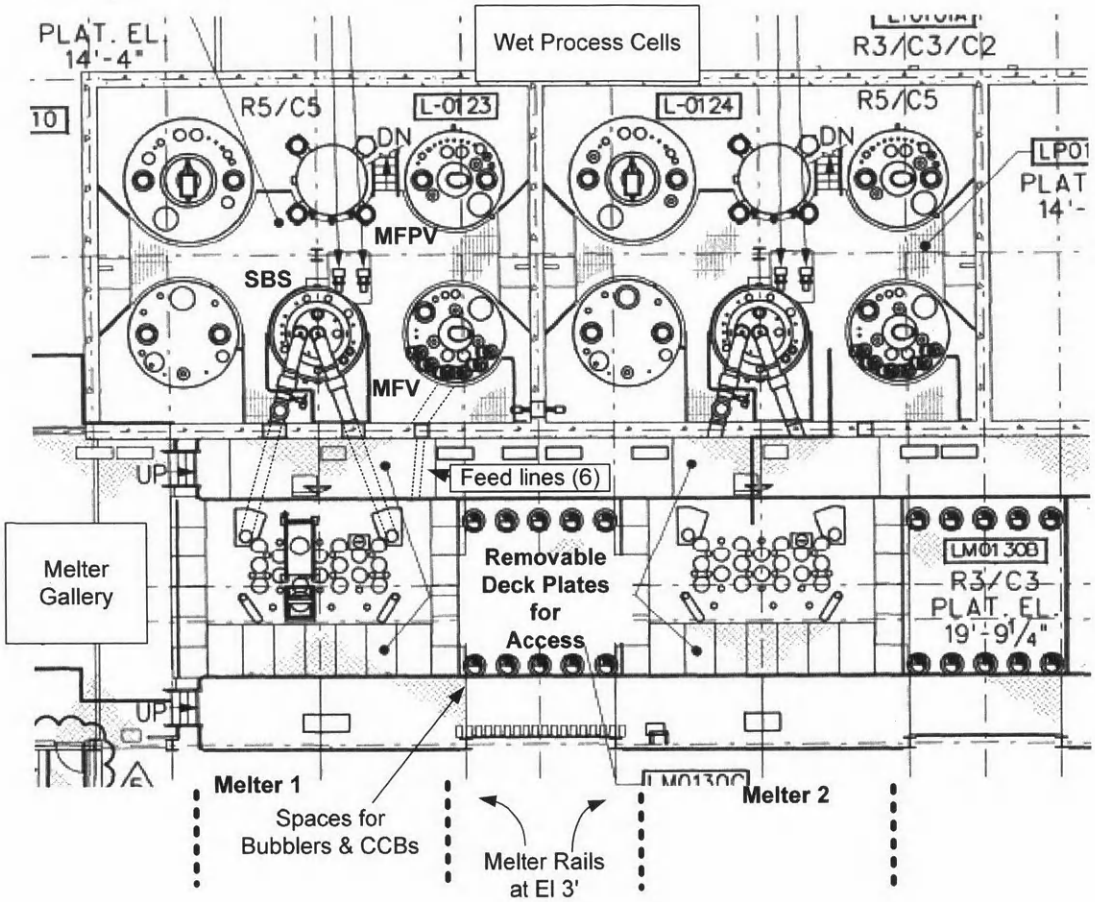
Refer to General Arrangement Plan Elevation Drawings for LAW Vitrification Building:

3 ft elevation	24590-LAW-P1-P01T-00002
28 ft elevation	24590-LAW-P1-P01T-00004
48 ft elevation	24590-LAW-P1-P01T-00005
68 ft elevation	24590-LAW-P1-P01T-00006

The film coolers are located in the primary (EO1) and secondary or standby (WO1) offgas ports in the melter lid. Both ports are on the north side of the melter, in the melter gallery at the 3-foot elevation. They are located to accommodate the shortest paths available to the SBS. The SBS is in the wet process cell adjacent to the cell wall and the melter. There are special high temperature penetrations through the wall for the two offgas lines. Figure 4-2 shows the relative locations of the melter, SBS, condensate tank and WESP.

LOP-SCB-00001 and LOP-SCB-00002 are located in rooms L-0123 and L-0124, respectively, of the process cell at the 3-foot elevation.

Figure 4-1 Layout of LAW Wet Process Cells



LOP-WESP-00001 and LOP-WESP-00002 are located at the 3-foot elevation in the same rooms (L-0123 and L-0124, respectively) of the process cell as their corresponding SBS and supporting LOP, LFP, and LCP collection vessels.

The HEPA filters and electric heater elements are located in room L-0304H at the 48-foot elevation; see general arrangement drawing 24590-LAW-P1-P01T-00005.

The two carbon bed adsorber units (LVP-ADBR-00001A and -00001B) are mounted on a common skid (LVP-SKID-00001) located in room L-0304F, at the 48 ft. elevation.

The LAW catalytic oxidizer / reducer skid LVP-SKD-00002 is to be located in room L-0304F at the 48-foot elevation. The ammonia / air dilution skid is next to the SCO/SCR in room L-0322A.

The caustic scrubber is at the 48-foot elevation in the open space L-0304 and extends through the 68-foot level into an extension in the roof and is covered by an access hatch. The caustic collection tank is located in room L-0218 at the 28-foot elevation.

The exhausters are located at the 48-foot elevation of the facility, in rooms L-0304C, L-0304D, and L-0304E (see general arrangement drawing 24590-LAW-P1-P23T-00052).

The exhaust stack is located on the exterior of the LAW Facility and extends above the roof on the northwest corner to a nominal elevation of 200 feet.

4.1.4 Principles of Operation

This section is currently reserved and will be updated in a later phase after work to support this section is complete.

4.1.4.1 Offgas Composition

Melter offgas is generated from the vitrification of LAW slurry feed by joule-heated ceramic melters. The offgas consists primarily of:

- Air from in-leakage into the melter, instrumentation, purges, and melter bubbler operation
- Water evaporated from the melter feed and cold cap chemical reactions
- Acid gases (e.g., HCl, HF) generated from anion reaction
- Priority pollutants (e.g., NO_x, SO_x) generated from anion reaction
- Greenhouse gases (e.g., CO_2) generated from anion reaction
- Aerosols from glass dried melter feed and melter cold-cap reaction solids
- Semivolatile metals or oxides generated from the molten glass pool
- Soluble radioactive materials not partitioned to the High-Level Waste Facility

Air is needed to prevent solids buildup in the offgas line. Air is also added for melter plenum pressure control just downstream of the film cooler. Air flow is adjusted to facilitate melter pressure control (see Section 4.1.1.1.2)

Additional discussion of system operations is provided in Section 4.2.

4.1.4.2 Process Operation

A primary function of the LOP system is to control melter plenum pressure. Melter emissions primarily consist of air, water in the form of steam, and decomposition gases. The rate of emission is highly variable and prone to surges. The variability is mostly from the rate of steam generation as slurry interacts with the hot melter surface and cold cap. To accommodate the rapid variation in offgas flow, excess air is fed to the system as a baseline operation. The quantity of this pressure control air is adjusted by a control valve which modulates based on the melter pressure signal. The melter is also designed to allow air leakage into the system to purge the corrosive hot gases out of potential dead spots. This leakage air will also vary based on melter pressure, further mitigating flow surges.

Hot, particulate-laden offgas exits the melter and is first cooled by the film cooler, then quenched in the SBS. Large particulate and water are removed in the water-filled bed; gases exit saturated with water at 140 °F, the SBS water temperature. The condensate is collected and recycled. The quenched offgas is then sprayed with a fine mist of water at the inlet of the WESP, which enhances the effectiveness of the charged plates of the WESP. The water spray also assists in removal of collected particulate as it is washed off the collector plates. The temperature of the offgas is then raised by 20 °F to avoid potential condensation of water as the final particulate removal takes place in the HEPA filters.

Toxic gas removal is the focus of the rest of the offgas equipment. The mercury absorber utilizes sulfur impregnated on activated carbon to react with the mercury and hold it on the bed. The granulated activated carbon is mixed with a zeolite material to enhance heat removal from the bed. The activated carbon will absorb many different chemicals exothermally, which can cause the bed to heat up. Carbon monoxide levels are monitored as a sign of carbon combustion due to local hot spots in the bed.

Two absorber units are piped in a lead–lag configuration to provide initial clean up and polishing. Each carbon bed is followed by an acid gas absorbent (Sofnolime). These absorber beds are positioned before the catalyst skid to remove or reduce the elements that could poison the catalyst, primarily the mercury, sulfur, and halides.

Gases from the carbon beds are sent to an economizer heat exchanger to collect energy from the hot gases exiting the catalyst skid. The skid outlet gases are partially cooled and the inlet gases warmed prior to entering a preheater, which brings the gases to the required catalyst operating temperature.

Residual organic constituents and products of incomplete combustion are oxidized on platinum catalyst (BASF VoCAT 300S), and then NO_x reacts with ammonia gas over a vanadia/ titania catalyst (BASF VNX 300) to form nitrogen gas and water. Liquid ammonia is supplied from the ammonia skid, which includes an evaporator and air dilution steps, prior to delivering the ammonia-air mixture to the catalyst skid in the LAW Facility.

The gases from the heat exchanger are further cooled by an atomized water spray prior to entering a caustic scrubber for final acid gas removal. The caustic in the scrub solution absorbs acid gases, including CO_2, which forms a buffered solution for stable operation of the scrubber. The buffer solution is pumped over a structured packing to contact the offgas. A mist eliminator at the scrubber is the final treatment step.

The cooled gases from the caustic scrubber are sent to the stack by the seven stage turbine exhausters. Three exhausters are provided. One exhauster is needed for simple ventilation of the melter system, while two are needed to support operation.

Offgas is monitored for NO_x, CO, total hydrocarbons and radioactivity at the exhaust stack.

4.1.5 System Reliability Features

RESERVED for future use.

4.1.6 System Control Features

Control of the LOP/LVP system is accomplished with various types of monitoring instrumentation, including its associated setpoints with feedback, to provide alarms, trips, interlocks, and indications of operation within the operation design envelope.

The offgas piping must confine melter offgas and direct the offgas through the exhaust stack to ensure that facility workers, co-located workers and public exposure standards are not exceeded during all operating and abnormal operating conditions and during all design basis natural forces events.

The location for monitoring and controlling the LOP/LVP system is the control room.

A primary design criteria is to maintain a vacuum in the LOP/LVP system from the melter plenum to the exhausters in order to contain all hazardous and radiological constituents.

To summarize normal pressure control through the system: The exhausters are set to provide sufficient negative pressure in the LVP system. This system draws on each set of primary equipment and melter. Melter pressure is controlled by varying air injection flow into the film cooler. The amount of air injected is then adjusted by action of a control valve at the WESP outlet. Header vacuum for both melters is maintained at the common connection point for the two offgas systems, upstream of the HEPA preheater units to provide stable operating vacuum for each LOP train to discharge to. This header vacuum setpoint is set to accommodate anticipated melter pressure transients without exceeding the response range of the WESP outlet valve for each melter. If an individual melter transient exceeds the WESP outlet valve response capability, melter pressure interlocks act on other pressure control sources, as previously described, to minimize melter offgas flow and open the standby offgas line. These actions reduce the likelihood of melter pressurization. This system has been modeled to show that pressure control can be maintained through melter steam surges as high as seven times nominal.

A loss of normal power event will be managed by automatic corrective action, which will place the system in a configuration which allows exhausters (on UPS backup power) to continue to direct the offgas flows through the stack and reduce the hazard until cold caps burn off.

4.1.6.1 LOP System Control Features

The process offgas system is designed to maintain -5 in. WG at the melter, which is below the pressure of the LAW C5V ventilation system. The gas generation rate (mostly steam) can vary widely. The challenge for the system is to maintain negative pressure in the face of this variation. Negative pressure in the melter cavity ensures that air leaks into the melter from the melter shielded enclosure. Leaks are engineered into melter components to clear corrosive vapors and to cool them. Besides the in-leakage air, there are several sources of air supplied to the melter. The motive force to maintain this flow is provided by the LAW exhausters, located at the far end of the offgas train. Three 50 % capacity exhausters provide vacuum to the system. The exhausters have variable speed drives that are adjusted to accommodate the overall air flow through the process, including both melters, with provision for a third melter if desired at a later date. Exhauster speed is regulated based on pressure at the LVP HEPA preheaters. There is no direct logic tie from the melter pressure and the exhausters.

Melter plenum pressure is measured at three points. All of the measurements are made against independent reference legs connected to the shield lid (C5V). The melter is equipped with a three-leg bubbler (pneumericators), which provides pressure, fluid density, and level from differential pressure signals. PDT-1410 measures the DP from the plenum to the annulus. This reading is compared to PDT-1411, which is measured at the back-up film cooler to the annulus. There is comparison logic with the higher reading selected. That reading is then used to control air injection to the melter, at the film cooler. There is a HI pressure alarm (only) and a high-high pressure alarm and trip that:

- Interrupts slurry feed (via feed interlock) to the melter by blocking air and water to the ADS pumps.
- Sets air flow to the film cooler and pressure control air to zero.
- Opens the valve to ventilate through the standby line.
- Shuts down the purge from the standby film cooler.
- Prevents air and water purges of either the film cooler or standby film cooler.
- Shuts off purge air to the WESP electrodes.
- Closes the vessel vent header pressure control valve.

The final safety-related melter pressure measurement is taken from melter nozzle WS-1(A), which is redundantly measured by PDT-1528 and PDT-1529. These safety related instruments have alarms for out of range (failure)

and if they don't agree with each other. Additionally, one or the other instrument can be deactivated from the control screen for maintenance or calibration. The high-high pressure alarm from these instruments is a feed interlock that locks in to keep melter feed off until manually reset. As discussed above, this is an automatic waste feed cutoff which:

- Latches all of the alarms listed above for high-high pressure, LMP-PDT-1410A.
- Closes control valve for the vessel vent header.
- Shuts off purge air to WESP.
- Shuts off ammonia and ammonia dilution air to the SCR in the catalyst skid.
- Resets at HS-9002 in PPJ.

The control features for the film cooler are as follows.

There is a high temperature interlock for the film coolers, because there is a risk of a breach of the offgas confinement boundary if operated at the higher plenum temperature. The in-bleed assembly valve will open to allow air to be drawn through the plant service air pipe and increase the flow of lower-temperature air to the film cooler if the high temperature interlock setpoint is reached.

The control features for the SBS are as follows.

The SBS has both high and low level interlocks which turn off the demineralized water supply or shut down the purge pumps in order to maintain the desired liquid level in the SBS. If the liquid level continues to decrease, the ADS feed melter feed pump will be stopped by a low-low level interlock. When the opposite happens and a high-high level interlock is reached the condensate purge pumps will be prevented from adding more condensate liquid.

The control features for the WESP are as follows.

A butterfly valve, FV-1140 / 2140, at the outlet of each WESP, regulates air from each melter into the LVP system based on the melter air injection rate. Pressure control transients will tend to demand more control air; control action will return air flow to the nominal flow to maintain air availability for pressure control response. Additionally, higher demand (% open) at the control valve indicates system degradation and higher in-leakage. This control loop will help separate the two melter systems and limit interaction.

With offgas flows already established, gases from startup water addition and melter feed are accommodated by reducing the air injection flow at the melter. If a gas surge from the melter occurs, then air injection is reduced, and if high pressure trip points are reached, injection and other air inputs are shut off. There are multiple points were continued control actions are taken to maintain control.

4.1.6.1.1 LOP System Monitoring

4.1.6.1.2 LOP Control Capability and Locations

There are four units of operation, film cooler, SBS, WESP, Control loops associated with the LOP are listed in Table 4-3.

Table 4-3 Control Loops for LOP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[1]
LOP-FCLR-00001	LOP-PC-1105		Controls flow of control air to primary offgas film cooler by modulating valve LOP-PV-1105 to achieve a melter plenum pressure of -5 in. WG relative to annulus	See CDI
	LOP-FC-1113		Controls injection air flow to primary offgas film cooler by modulating valve LOP-FV-1113 on plant service air supply	See CDI
LOP-SCB-00001	LOP-TC-1013A LOP-TC-1013B		Controls SBS temperature by modulating valves LOP-TV-1013A/B on chilled water return from cooling coils and jacket (A & B respectively)	See CDI
LOP-VSL-00001	LOP-TC-1015		Controls SBS condensate vessel temperature by modulating valve LOP-TV-1015 on chilled water return from cooling jacket	See CDI
LOP-WESP-00001	LOP-FC-1050		Controls air flow to WESP by modulating valve LOP-FV-1050 on process air supply	See CDI
	LOP-TDC-1092		Controls air temperature to WESP by adjusting power to heater LOP-HTR-00001 based on differential between offgas and process air supply temperatures	See CDI
	LOP-FC-1140		Controls offgas flow from WESP by modulating valve LOP-FV-1140 based on control air flow to primary offgas film cooler	See CDI
LOP-FCLR-00003	LOP-PC-2105		Controls flow of control air to primary offgas film cooler by modulating valve LOP-PV-2105 to achieve a melter plenum pressure of -5 in. WG relative to annulus	See CDI
	LOP-FC-2113		Controls injection air flow to primary offgas film cooler by modulating valve LOP-FV-2113 on plant service air supply	See CDI
LOP-SCB-00002	LOP-TC-2013A LOP-TC-2013B		Controls SBS temperature by modulating valves LOP-TV-2013A/B on chilled water return from cooling coils and jacket (A & B respectively)	See CDI
LOP-VSL-00002	LOP-TC-2015		Controls SBS condensate vessel temperature by modulating valve LOP-TV-2015 on chilled water return from cooling jacket	See CDI
LOP-WESP-00002	LOP-FC-2050		Controls air flow to WESP by modulating valve LOP-FV-2050 on process air supply	See CDI

[1] Setpoints and references will be listed in the Configuration Data Index (CDI - not yet issued) for the LOP and LVP systems'.

Table 4-3 Control Loops for LOP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[1]
	LOP-TDC-2092		Controls air temperature to WESP by adjusting power to heater LOP-HTR-00002 based on differential between offgas and process air supply temperatures	See CDI
	LOP-FC-2140		Controls offgas flow from WESP by modulating valve LOP-FV-2140 based on control air flow to primary offgas film cooler	See CDI

4.1.6.1.3 LOP Automatic and Manual Actions

RESERVED

4.1.6.1.4 LOP Setpoints and Ranges

RESERVED

4.1.6.1.5 LOP Interlocks, Bypass, and Permissive

Operating trips, alarms, and interlocks associated with the LOP system are listed in Table 4-4.

Table 4-4 Trips, Alarms and Interlocks for LOP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[2]
LFP-PMP-00007 Through LFP-PMP-00018	LFP-YC-1208A LFP-YC-2208A		Interlock – Open of Valves LOP-YV-1002, LVP-YV-0097, -0403, or -0501: Causes valves LFP-YV-1208 and LFP-YV-2208 to close	LOP 01005, F6 LVP 02001, D5 LVP 04001, E5 LVP 05002, E4
LMP-MLTR-00001	LMP-PDSHH-1528, LMP-PDSHH-1529 LMP-PDSHH-1410A		High-high pressure trip Closes valves: LFP-YV-1207 & -1208, Closes valves: LOP-PV-1105 & -FV-1113 Opens valve LOP-YV-1008, and Closes valves LVP-YV-0528 & -0538[2]	See CDI LMP 00002, D2 LOP 01005, D5 LOP 04002, F8
LOP-FCLR-00001, LOP-FCLR-00002	LOP-TE-1062, LOP-TE-1066, LMP-TT-1322		High temperature alarm on LMP-TT-1322	See CDI LOP 01005, B5 B7 LMP 05001, A5
LOP-SCB-00001	LOP-LAHH-1011,		High-high level alarm	See CDI LOP 01001, F4 LOP 01006, E5 E6 LOP 01002, F6 G6
	LOP-LSHH-1011, LOP-LSHH-1063		High-high level trip stops pumps: LOP-PMP-00001, LOP-PMP-00002, and closes valves: LOP-YV-1156, LOP-YV-1157	
	LOP-LALL-1011,		Low-low level alarm	See CDI LOP 01001, E4 F3 LOP 01006, E4 G4
	LOP-LSLL-1063		Low-low level trip stops pumps: LOP-PMP-00003A/B	
	LOP-TI-1013		High temperature alarm	See CDI LOP 01001, B3 C5 D3
	LOP-TI-1013		High temperature trip closes valve: LOP-TV-1013A	
LOP-VSL-00001	LOP-LSHH-1018A		High-high level alarm	See CDI LOP 01002, E6 LOP 01001, G7 D3 LOP 01003, E6

[2] Setpoints and references will be listed in the Configuration Data Index (CDI - not yet issued) for the LOP and LVP systems'.

[2] Implementation of a time lag (duration TBD) before executing the melter plenum pressure interlocks is on hold pending ISM review.

Table 4-4 Trips, Alarms and Interlocks for LOP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[2]
	LOP-LSHH-1018A		High-high level trip closes valves: LOP-YV-1056 LOP-YV-1029 LOP-TV-1013A LOP-YV-2005	
	LOP-LSLL-1018A		Low-low level alarm	See CDI LOP 01003, E6 D5 D6
	LOP-LSLL-1018A		Low-low level trip stops pumps: LOP-PMP-00001 LOP-PMP-00002	
LOP-WESP-00001	LOP-LAHH-1059,		High-high level alarm	See CDI LOP 01004, E3 C7 G6
	LOP-LSHH-1059, LOP-LSHH-1060		High-high level trip closes valves: LOP-YV-1061 LOP-YV-1080	
LMP-MLTR-00002	LMP-PDSHH-2410A		High-high pressure trip Closes valves: LFP-YV-2207 & -2208, Closes valves: LOP-PV-2105 & -FV-2113 Opens valve: LOP-YV-2008, and Closes valves: LVP-YV-0528 & -0538[3]	See CDI LMP 32002, D5 LOP 02005, D5 LOP 05002, F8
LOP-FCLR-00003, LOP-FCLR-00004	LOP-TE-2062, LOP-TE-2066, LMP-TT-2322		High temperature alarm on LMP-TT-2322	LOP 02005, B5 B7 LMP 35001, A5
LOP-SCB-00002	LOP-LAHH-2011, LOP-LAHH-2063		High-high level alarm	TBD
LOP-SCB-00002	LOP-LAHH-2011,		High-high level alarm	LOP 02001, F3 F4 LOP 02006, D5 F5 LOP 02002, F6 G6
	LOP-LSHH-2011, LOP-LSHH-2063		High-high level trip stops pumps: LOP-PMP-00004, LOP-PMP-00005, and closes valves: LOP-YV-2056, LOP-YV-2057	
	LOP-LALL-2011,		Low-low level alarm	LOP 02001, F4 LOP 02006, E4 G4
	LOP-LSLL-2063		Low-low level trip stops pumps: LOP-PMP-00006A/B	
	LOP-TI-2013		High temperature alarm	

[3] Implementation of a time lag (duration TBD) before executing the melter plenum pressure interlocks is on hold pending ISM review.

Table 4-4 Trips, Alarms and Interlocks for LOP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[2]
	LOP-TI-2013		High temperature trip closes valves: LOP-TV-2013A/B	LOP 02001, C5 B3 D3
LOP-VSL-00002	LOP-LSHH-2018A		High-high level alarm	9.23 ft LOP 02002, E6 LOP 02001, G7 D3 LOP 02003, E6
	LOP-LSHH-2018		High-high level trip closes valves: LOP-YV-2029 LOP-YV-2056 LOP-TV-2013A LOP-YV-2006	
	LOP-LSLL-2018A		Low-low level alarm	0.66 ft LOP 02002, E6 D5 D6
	LOP-LSLL-2018A		Low-low level trip stops pumps: LOP-PMP-00004 LOP-PMP-00005	
LOP-WESP-00002	LOP-LAHH-2059		High-high level alarm	LOP 02004, E3 C7 G6
	LOP-LSHH-2059, LOP-LSHH-2060		High-high level trip closes valves: LOP-YV-2061 LOP-YV-2080	

Recovery actions required on detection of faults and process upsets in the LVP system are described in the following subsections.

The liquid level instrumentation is interlocked to shut off WESP demineralized flush water and prevent inadvertent flooding. (The WESP liquid levels block the inlet port and offgas release path, thereby increasing melter plenum pressure.)

4.1.6.2 LVP System Control Features

The control features for the HEPA preheaters are as follows.

HEPA Preheaters – HEPA preheaters are present to prevent condensation accumulation on the HEPA filters, thereby increasing the differential pressure and reducing flow across the HEPA filters. However, too high a temperature may compromise the offgas system confinement boundary downstream and this necessitates a high temperature interlock to de-energize preheater power.

The control features for the HEPA filters are as follows.

Multiple HEPA Train – The isolation valves must not be able to isolate both filter trains simultaneously.

The control features for the adsorber bed are as follows.

CO_x - Hg Detection – The temperature of the carbon beds must be kept below the ignition temperature, so a high temperature interlock is used to isolate and bypass the carbon bed if the incoming offgas is too hot. If the carbon

does begin to thermally decompose, and risk both a fire with rapid mercury desorption and release, a differential CO/CO_2 monitor will activate closed the same bypass valve. There is a water line supplied to the adsorber for fire suppression if necessary, accompanied by a high fluid level interlock to shut it off. If there is a plugging of the unit, it will be detected by a differential pressure monitor. Finally, there is a post-bed mercury monitor, which can stop melter feed if the bed experiences a breakthrough.

The control features for the SCO/SCR ammonia supply skid are as follows.

Manage NH_3 and NO_x – Ammonia flow to the skid must be stopped if the flows are out of balance for chemical reaction. This will happen if the ammonia supply flow is relatively too high, air flow is too low, or differential pressure is out of range. Temperature must be monitored so it does not compromise offgas confinement of the oxidizer / reducer skid. If the heater becomes too hot, ammonia flow will stop and the skid will be isolated.

The control features for the caustic scrubber are as follows.

Quench Water Sprays – The hot offgas stream entering the bottom of the scrubber is cooled by evaporation of a portion of the quench water sprayed into the bottom of the column to minimize the scrubber outlet gas temperature of the offgas and enhance gas absorption in the packed section.

Caustic Scrubber Overall DP – The caustic scrubber overall DP is measured in the scrubber from below the packing to above the demister section and provides indication of the DP across the entire scrubber.

Scrubber Packing Section/DP – The scrubber packing provides a large surface area for intimate contact between the gas stream and recirculating buffer solution. The DP across the packing section is dependent on the liquid flow rate, the gas flow rate, and the condition of the packing, whether clean or fouled by solids. The solution flow rate can be controlled, however there is no direct control of the gas flow rate nor any direct control for solids fouling the packing. The solution flow rate will be maintained well below the packing flood point at a constant value to provide a baseline normal operating value for the packing DP. While there is no control of the gas flowrate, the variations in the gas flow rate will be measured to evaluate whether the DP increase is due to solids accumulation in the packing or just normal DP increase from increased gas flow. Solids accumulation on the bottom of the packed section may be flushed using existing water sprays.

Demister Elements/Demister DP – The demister DP is used to determine when the demister periodic water flush should be used. Note: The current design has omitted demister DP instrumentation entirely, even though the design already provides the pressure tap piping necessary for the addition of a pressure transmitter and DP instruments to display the demister DP.

Scrubber Drain Pipe/Hydraulic Pressure Seal – The scrubber drain piping is 8 inches from the bottom of the scrubber and routes the scrubber solutions to the top of the caustic collection tank. The drain piping has a long, near-horizontal 16-inch pipe section that provides a liquid volume in the drain that will maintain a liquid hydraulic seal between the scrubber operating under vacuum and the caustic collection tank that operates at atmospheric pressure.

Hydraulic seal failure (i.e., seal loop not full of solution) would allow air in-leakage with a loss of vacuum being detected. (Normally once the seal is filled, it will remain functional from that point on. During operation, about 200 gpm of solution continuously passes through the seal loop and drains into the caustic collection tank. There is a drain pipe and valve at the bottom of the seal loop that can be opened to drain the loop. Refill of the loop would be performed via the various sprays in the caustic scrubber.)

Caustic Collection Tank (LVP-TK-00001) – The caustic collection tank buffer solution volume is maintained to support the recirculation of restored buffer solution to the top of the packing in the scrubber for absorption of the acid gases.

Buffer Solution pH:

Caustic Buffer Solution Recirculation System – The recirculation pumps supply fresh buffer solution on the top of the packing for acid gas absorption. The flow rate is controlled at a constant value at which a packing flood cannot occur.

Caustic Buffer Solution Blowdown System – Normally the caustic blown-down pump solution flow will be continuously recirculated at about 120 gpm back to the caustic collection solution to enhance buffer mixing. Periodically the flow will be routed to remove excess solution out of the tank to the RLD system as dictated by the buffer solution level in the caustic collection tank.

Buffer Solution pH/Operation and Maintenance – The pH of the buffer solution is determined by the $Na_2CO_3/NaHCO_3$ mole ratio. The buffer solution pH is measured in the solution that is continuously being withdrawn from the bottom of the caustic collection tank for recirculation to the top of the packing. The pH values determined by the pH system are used to determine if the continuous 5 molar sodium hydroxide addition rate is adequate and if not, whether the rate should be increased or decreased. For pH values trending down, the rate will be increased and for pH values trending upward, the rate will be reduced.

Buffer Solution pH Measurement – The buffer solution pH system continuously measures the buffer solution pH at the recirculation pump suction to provide guidance on the 5 molar sodium hydroxide rate adjustments.

Five Molar Caustic Addition System – Five molar sodium hydroxide is continuously added to the caustic blowdown transfer pump suction pipe as it pumps buffer solution from the bottom of the caustic collection tank. The solution is returned to the top of the tank at about 120 gpm. The caustic reacts with sodium carbonate in the buffer solution, converting sodium carbonate to sodium bicarbonate to restore the sodium carbonate/sodium bicarbonate mole ratio, which restores the original pH. (See buffer solution above).

4.1.6.2.1 LVP System Monitoring

The caustic scrubber is monitored for the following.

Scrubber Outlet Gas Temperature – The scrubber outlet gas temperature must be maintained below the maximum temperature value on the rate sheet to prevent damage to the exhausters, which have a maximum inlet gas temperature specified by the vendor. (Monitor TI-0236 and TI-0237 on P&ID) Monitor the water pressure and flow rates to the four quench water sprays to maintain proper quench spray operation. (PI-0227, 229, 231, and 233 and FI-0207, 9, 11, and 12 on P&ID) Monitor the air pressure and flow rates to the four quench water sprays. (PI-0226, 228, 230, and 232 and FI-0206, 208, 210, and 212 on P&ID)

Scrubber Packing Section DP – The packing section DP must be maintained well below the flood point where the solution holdup within the packing increases until the gas flow path is actually flooded, which causes a stop in air flow and pressurizes the scrubber. Monitor the scrubber DP (DPI-0214 on P&ID) that is located on the control panel. Monitor the buffer solution recirculation flow rate (FI-0065 and FI-0221 on P&ID) both located on the control panel. Monitor the offgas flow rate, measured in the 18" offgas line between the HEPA filters and the SCR/SCO unit, (FI-0506 on P&ID) located on the control panel. For periodic flushing of the bottom of the packing, monitor the flush water pressure and flow rate (FI-0202 on P&ID).

Demister Elements/Demister DP – The demister media can be water flushed to reduce the DP using the four spray nozzles. For periodic flushing of the demister media, monitor the flush water pressure and flow rate (FI-0202 on P&ID).

Caustic Scrubber Overall DP – The overall scrubber DP is monitored by reading PDI-0093 (on P&ID).

Scrubber Drain Pipe/Hydraulic Pressure Seal – There is no liquid level instrumentation on the scrubber drain hydraulic seal.

4.1.6.2.2 LVP Control Capability and Locations

Control loops associated with the LVP are listed in Table 4-5.

The caustic scrubber control capability is for the following.

Scrubber Outlet Gas Temperature – The only means of controlling the scrubber outlet gas temperature is by maintaining proper operation of the quench water sprays. TE-0236 and TE-0237 are located on the 18 in. scrubber outlet line, and TI-0236 and TI-0237 are located in the control room. All quench nozzle instrumentation is located locally near the bottom of the scrubber.

Caustic Scrubber Overall DP – The only control of the scrubber overall DP will be accomplished by performing periodic water flushes of both the packing and demister for DP reduction.

Scrubber Packing Section/DP – There is no control of the melter offgas stream flow rate; therefore, the only readily available control to quickly reduce the packing DP is to reduce the recirculating buffer solution flow rate. If the rise in packing DP is from solids accumulation and the periodic water sprays to the bottom of the packing do not reduce the DP, then there will have to be a caustic scrubber bypass outage to allow acid flush of the packing.

Demister Elements/Demister DP: The demister DP will be a function of the offgas flow rate through the demister media and the permeability of the demister media. There is no control of the offgas flow rate and the permeability of the demister media will be gradually reduced as material is removed from the offgas stream and accumulates on and within the demister media. Four demister water spray nozzles are provided to periodically water wash the surface of the demister media as a control of the demister DP. Because the demister media must retain the extremely small droplets through Brownian capture in the media, it is necessarily a depth filter where the droplets will migrate well within the media rather than being stopped at the media surface. If the demister spray water does not reduce the demister DP over time, the demister elements will have to be replaced during a caustic scrubber outage. The demister DP is not measured or displayed on any instrument.

Note: The current design has omitted demister DP instrumentation entirely even though the design already provides the pressure tap piping necessary for the addition of a pressure transmitter and DP instrumentation to display the demister DP.

Table 4-5 LVP Control Loops for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[4]
Vessel Vent Header	LVP-PC-0072		Controls vessel vent header pressure by modulating valve LVP-PV-0072	See CDI
LVP-HTR-00001A	LVP-JC-0004A		Controls HEPA filter inlet temperature by adjusting power to LVP-JZ-0004A	See CDI
LVP-HTR-00001B	LVP-JC-0004B		Controls HEPA filter inlet temperature by adjusting power to LVP-JZ-0004B	
LVP-EXHR-00001A/B/C	LVP-PC-0023 LVP-PC-0020 LVP-PC-0017		Controls inlet pressure to HEPA filter preheaters by adjusting speed of exhausters	See CDI
LVP-SKID-00002	LVP-TC-0510		Controls VOC catalyst inlet temperature by adjusting power to LVP-JC-0510	See CDI
LVP-SKID-00003	LVP-AC-0523		Controls ammonia outlet concentration from catalytic oxidizer/reducer by modulating valve LVP-AV-0523 on ammonia supply	See CDI
	TBD pending vendor design		Controls ammonia inlet concentration to catalytic oxidizer/reducer by maintaining flow ratio of ammonia to air	See CDI
	LVP-AC-0051		Controls caustic collection tank pH by adjusting caustic flow from pump SHR-PMP-00018A/B by LVP-AV-051	See CDI
LVP-TK-00001	LVP-DC-0065		Controls caustic collection tank density by modulating valve LVP-DV-0065 on process water supply	See CDI

4.1.6.2.3 LVP Automatic and Manual Actions

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4.1.6.2.4 LVP Setpoints and Range

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4.1.6.2.5 LVP Interlocks, Bypass, and Permissive

Operating trips, alarms, and interlocks associated with the LVP system are listed in Table 4-6.

The caustic scrubber has the following.

[4] Setpoints and references will be listed in the Configuration Data Index (CDI - not yet issued) for the LOP and LVP systems'.

Recirculation Line Isolation on Low Pressure – The caustic scrubber recirculation line isolation interlock closes the caustic scrubber recirculation line isolation valve on detection of low pressure in the caustic scrubber recirculation line, whenever any melter has a cold cap.

Process Water Isolation on Low Pressure – The caustic scrubber process water line isolation interlock closes the caustic scrubber process water line isolation valve on detection of low pressure in the caustic scrubber process water line, whenever any melter has a cold cap.

Scrubber Outlet Gas Temperature – The current design includes three interlock actions that are triggered by high scrubber outlet gas temperature:

- The power to the catalytic oxidizer electric heater is isolated.
- The SCO/SCR skid bypass valve is opened.
- The ammonia supply to the SCO/SCR skid is isolated.

Response to Detection of Caustic Scrubber Bypass Valve Not Closed. The SCO heater shall be shut off, SCO skid shall be bypassed, and ammonia flow to the SCO skid shall be isolated on detection of caustic scrubber bypass valve not closed.

Bypass Caustic Scrubber on High DP. The caustic scrubber bypass valve interlock must actuate the caustic scrubber bypass valve open on detection of high differential pressure across the caustic scrubber, whenever any melter has a cold cap. This will open the bypass line to maintain an unrestricted flowpath for the offgas.

Caustic Scrubber Overall DP – The current design includes an interlock action to bypass the caustic scrubber when the overall scrubber DP (DPI-0093) reaches the high setting. Three multiple interlock actions in the current design concerning maintaining an open flow path through the scrubber, including three interlock actions actuated by the caustic scrubber overall high DP.

Scrubber Packing Section DP – There are no interlock actions actuated by the scrubber packing section DP.

Demister Elements/Demister DP – There are no interlocks actions actuated by the demister DP.

Caustic Scrubber (PDSA Section 4.4.9) Maintenance of an Open Flowpath Through or Around the Caustic Scrubber – The operation of the caustic scrubber DP monitor, recirculation line isolation valve, spray water addition valve, and bypass valve interlocks shall maintain an open flowpath from the melter to the exhaust stack. The operation of the pressure instrumentation and associated isolation valve interlocks on the normally pressurized recirculation and process water lines ensure that melter depression is not lost due to excessive in-leakage through ancillary connections to the caustic scrubber. The operation of the flow instrumentation and associated melter feed termination interlocks ensure that confinement is not lost through the drain line from the caustic scrubber to the caustic collection tank.

Response to Detection of Caustic Scrubber Bypass Valve Not Closed – The SCO heater shall be shut off, SCO skid shall be bypassed, and ammonia flow to the SCO skid shall be isolated on detection of caustic scrubber bypass valve not closed.

Process Water Isolation on Low Pressure – The caustic scrubber process water line isolation interlock must close the caustic scrubber process water line isolation valve on detection of low pressure in the caustic scrubber process water line, whenever any melter has a cold cap.

Bypass Caustic Scrubber on High DP – The caustic scrubber bypass valve interlock must actuate the caustic scrubber bypass valve open on detection of high DP across the caustic scrubber, whenever any melter has a cold cap. This will open the bypass line to maintain an unrestricted flowpath for the offgas.

Process Water Isolation on High DP Across Scrubber – The caustic scrubber water valve interlock must actuate closed the caustic scrubber spray water addition control valve on detection of high differential pressure across the caustic scrubber, whenever any melter has a cold cap. This safety function will close the water valve before levels rise too high, reducing the potential to flood the caustic scrubber to the point of blocking the melter offgas pathway and resulting in a melter offgas release.

Liquid Level in the Drain Line Loop Seal – Whenever any melter is operating, the liquid-filled loop seal on the drain line from the caustic scrubber to the caustic collection tank prevents in-leakage into the melter offgas system from the caustic collection tank drain line under bounding conditions from the downstream exhausters. The height of the loop seal must account for evaporative losses, such that a sufficient liquid level (capable of preventing in-leakage) will be maintained for a minimum of 2 hours following a loss of liquid flow to the caustic scrubber.

Scrubber Drain Pipe/Hydraulic Pressure Seal – There is no instrumentation monitoring the scrubber drain pipe or hydraulic pressure seal, and therefore no interlocks.

Caustic Collection Tank (LVP-TK-00001) – There are no safety interlocks actuated by tank instrumentation.

Caustic Buffer Solution Recirculation System – There are three interlocks concerning the caustic buffer solution recirculation system:

Recirculation Line Isolation on Low Pressure – The caustic scrubber recirculation line isolation interlock must close the caustic scrubber recirculation line isolation valve on detection of low pressure in the caustic scrubber recirculation line, whenever any melter has a cold cap.

Melter Feed Termination on Recirculation Line Low Flow – The caustic scrubber recirculation line flow detection instrumentation must monitor caustic scrubber recirculation line flow and must isolate the demineralized water and plant service air feeds to the ADS pumps within the melter feed vessels, terminating feed to the melters whenever low flow is detected. A timed delay in water isolation is allowed for flushing activities, with related analytical limits and setpoints accounting for this time delay.

Recirculation Line Isolation on DP Pressure Across Scrubber – The recirculation line isolation valve interlock must actuate closed the caustic scrubber isolation valve on the recirculation line from the caustic collection tank on detection of high differential pressure across the caustic scrubber, whenever any melter has a cold cap. This safety function will stop water additions from the caustic collection tank recirculation line before levels rise too high, reducing the potential for flooding the caustic scrubber to the point of blocking the melter offgas pathway and resulting in a melter offgas release.

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
LVP-HTR-00001A/B	LVP-TDI-0101		High differential temperature alarm based on LVP-TT-0101 & -0104	See CDI LVP 01002, G5

[5] Setpoints and references will be listed in the Configuration Data Index (CDI - not yet issued) for the LOP and LVP systems'.

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
	LVP-TDI-0101		High differential temperature trip de-energizes heaters LVP-HTR-00001A/B	
	LVP-TDI-0101		Low differential temperature alarm based on LVP-TT-0101 & -0104	See CDI LVP 01002, G5
LVP-HEPA-00001A/B, LVP-HEPA-00002A/B, LVP-HEPA--00003A	LVP-PDI-0083, LVP-PDI-0084		High-high differential pressure alarm	See CDI LVP 01003, E4 D2 LFP 02001 LFP 04001
	LVP-PDSHH-0083, LVP-PDSHH-0084		High-high differential pressure trip closes valves: LFP-YV-1207 LFP-YV-1208 LFP-YV-2207 LFP-YV-2208[2]	
	LVP-ZSL-0105, LVP-ZSL-0106, LVP-ZSL-0107, LVP-ZSL-0108		Closing of valves: LVP-YV-0105, LVP-YV-0106, Or closing of valves: LVP-YV-0107, LVP-YV-0108 Cannot isolate both HEPA filter trains at the same time	LVP 01003, E3 G7 LVP 01003, C4 E8
LVP-HEPA-00001A, LVP-HEPA-00002A, LVP-HEPA-00003A	LVP-PDI-0011, LVP-PDI-0012		High-high differential pressure alarm	See CDI LVP 01003, D5 D7 LVP 01003, E3 G7
	LVP-PDSHH-0011, LVP-PDSHH-0012		High-high differential pressure trip closes valves: LVP-YV-0105, LVP-YV-0106	
LVP-HEPA-00001B, LVP-HEPA-00002B,	LVP-PDI-0007, LVP-PDI-0008		High-high differential pressure alarm	See CDI LVP 01003, G4 G6 LVP 01003, C4 E8
	LVP-PDSHH-0007, LVP-PDSHH-0008		High-high differential pressure trip closes valves: LVP-YV-0107, LVP-YV-0108	

[2] Trip of melter feed upon high differential pressure across HEPA filters is on hold pending ISM review.

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
LVP-EXHR-00001A	LVP-YC-0023A		Failure of either exhauster: LVP-EXHR-00001B, or LVP-EXHR-00001C causes; LVP-EXHR-00001A to start.	LVP 01004, D5
	LVP-YC-0023B		Loss of normal power causes: LVP-EXHR-00001A to start and remain running for no less than 2 hours[3]	LVP 01004, D5
LVP-EXHR-00001B	LVP-YC-0020A		Failure of either exhauster: LVP-EXHR-00001A, or LVP-EXHR-00001C causes; LVP-EXHR-00001B to start.	LVP 01005, D5
	LVP-YC-0020B		Loss of normal power causes exhauster LVP-EXHR-00001B to remain running for no less than 2 hours.	LVP 01005, D5
LVP-EXHR-00001C	LVP-YC-0017A		Failure of either exhauster: LVP-EXHR-00001A, or LVP-EXHR-00001B causes; LVP-EXHR-00001C to start.	LVP 01006, D5
	LVP-YC-0017B		Loss of normal power causes exhauster LVP-EXHR-00001C to start and remain running for no less than 2 hours.	LVP 01006, D5
LVP-SKID-00001	LVP-PDAHH-0401, LVP-PDAHH-0402		High-high differential pressure alarm	See CDI LVP 04001, E5 F5 LVP 04002, E3 G3
	LVP-PDSHH-0401, LVP-PDSHH-0402		High-high differential pressure trip opens valve LVP-YV-0403, and closes valves LVP-YV-0407 & LVP-YV-0415	
	LVP-TAHH-0404, LVP-TAHH-0434		High-high temperature alarm	See CDI LVP 04002, H7

[3] Automatic switch-over to the standby exhauster by the PPJ system upon failure of one of the other exhausters during a loss of normal power is on hold pending ISM review.

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
	LVP-TSHH-0404, LVP-TSHH-0434		High-high temperature trip opens valve LVP-YV-0403, and closes valves LVP-YV-0407 & LVP-YV-0415	LVP 04002, E3 G3 LVP 04001, E5
	LVP-ADAHH-0405A LVP-ADAHH-0405B		High-high differential CO_x concentration alarm based on: LVP-AT-0405, & LVP-AT-0424, or LVP-AT-0406, & LVP-AT-0425	See CDI LVP 04002, A4 A6 LVP 04002, E3 G3 LVP 04001, E5
	LVP-ADSHH-0405A LVP-ADSHH-0405B		High-high differential CO_x concentration trip opens valve LVP-YV-0403, and closes valves LVP-YV-0407 & LVP-YV-0415	
LVP-ADBR-00001A	LVP-LI-0414		High-high level alarm	See CDI LVP 04003, G5
	LVP-TI-0410		High bed temperature alarm	See CDI LVP 04003, G6 G7
	LVP-TI-0411		High bed temperature alarm	
	LVP-TI-0412		High bed temperature alarm	
	LVP-TI-0413		High bed temperature alarm	
LVP-ADBR-00001B	LVP-LI-0422		High-high level alarm	See CDI LVP 04003, D5
	LVP-TI-0418		High bed temperature alarm	See CDI LVP 04003, D6 D7
	LVP-TI-0419		High bed temperature alarm	
	LVP-TI-0420		High bed temperature alarm	
	LVP-TI-0421		High bed temperature alarm	
LVP-SKID-00002	LVP-PDAHH-0502, LVP-PDAHH-0504		High-high differential pressure alarm	See CDI LVP 05002, G3 E3 E7 LVP 05001, F6 C3
	LVP-PDSHH-0502, LVP-PDSHH-0504		High-high differential pressure trip: Opens valve LVP-YV-0501, and closes valves: LVP-YV-0528 & LVP-YV-0538	
	LVP-FI-0506		Low flow alarm	See CDI LVP 05002, F5

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
	LVP-TI-0507		High temperature alarm	See CDI LVP 05002, E5
	LVP-TI-0508		High temperature alarm	See CDI LVP 05002, F6
	LVP-TAHH-0509		High temperature alarm	See CDI LVP 05002, F7 E7
	LVP-TSHH-0509		High temperature trip de-energizes heater LVP-HTR-00002	
	LVP-TI-0511		High temperature alarm	See CDI
	LVP-TSHH-0511		High temperature trip de-energizes heater LVP-HTR-00002	See CDI LVP 05002, F8
	LVP-TI-0513		High temperature alarm	See CDI LVP 05002, C8
	LVP-TI-0517		High temperature alarm	See CDI LVP 05002, C7
	LVP-TI-0519		High temperature alarm	See CDI LVP 05002, C6
	LVP-TSHH-0519		High temperature trip: Turns off Heater LVP-HTR-00002, and Opens valve LVP-YV-560	See CDI LVP 05002, C6 LVP 05001, F7
	LVP-TI-0519		Low temperature alarm	See CDI LVP 05002, C6 LVP 05001, F6
	LVP-TI-0519		Low temperature trip: Closes valve LVP-YV-0528	
	LVP-AI-0523		High ammonia concentration alarm	See CDI LVP 05002, B4
	LVP-TI-0524		High temperature alarm	See CDI LVP 05002, C4
	LVP-TAHH-0554		High-high temperature alarm	See CDI LVP 050021, D4 F7
	LVP-TSHH-0554		High-high temperature trip: de-energizes heater LVP-HTR-00002	
LVP-SKID-00003	LVP-FI-0529		High ammonia flow	See CDI LVP 05001, G5
	LVP-FI-0539		High air flow alarm	See CDI LVP 05001, D3
	LVP-FI-0539		Low air flow alarm	See CDI LVP 05001, D3 F7
	LVP-FSLL-0539		Low air flow trip: Closes valve LVP-YV-0528	

Table 4-6 Trips, Alarms and Interlocks for LVP System

Equipment No.	Instrument No.	Properties (Safety Classification)	Function	Setpoint/ Reference[5]
	LVP-FALL-0540 LVP-FALL-0541		Low-low air flow alarm	See CDI LVP 05001, D3 E3 LVP 05001, C3 F6
	LVP-FALL-0540 LVP-FSLL-0541		Low-low air flow trip closes valves LVP-YV-0528 & -0538	
LVP-SCB-00001	LVP-PDAHH-0047, LVP-PDAHH-0094		High-high differential pressure alarm	See CDI LVP 02001, G6 G7 D5 LVP 02002, F6
	LVP-PDSHH-0047, LVP-PDSHH-0094		High-high differential pressure trip stops pumps LVP-PMP-00003A/B, closes valve LVP-YV-0201, and opens valve LVP-YV-0097	
	LVP-LI-0090		High level alarm	See CDI LVP 02002, D4
LVP-TK-00001	LVP-LI-0055B		High-high level alarm	See CDI LVP 02003, F7 G7
	LVP-LSHH-0055B		High-high level trip closes valve LVP-DV-0065	
	LVP-LI-0055		Low-low level alarm	See CDI LVP 02003, F7 LVP 02004, D6 F6 LVP 02005, E6 G6
	LVP-LSLL-0055		Low-low level trip stops pumps LVP-PMP-00002A/B & LVP-PMP--00003A/B	

Recovery actions required on detection of faults and process upsets in the LVP system are described in the following subsections.

4.2 Operations

RESERVED

4.3 Testing and Maintenance

RESERVED

4.4 Supplemental Information

RESERVED

5 Sources, Bases, and Other References

5.1 Source / Basis References

Document Number	Rev	Title	Text Reference
24590-WTP-DB-ENG-01-001	3	*Basis of Design*	BOD
24590-WTP-RPT-OP-01-001	6	*Operations Requirements Document*	ORD
24590-WTP-PSAR-ESH-01-002-03	5L	*Preliminary Documented Safety Analysis to Support Construction Authorization; LAW Facility Specific Information*	LAW PDSA
24590-WTP-SRD-ESH-01-001-02	007F	*Safety Requirements Document, Volume II*	SRD
DE-AC27-01RV14136	M345	*DOE/BNI WTP Contract Mod No. 304, Section C - Statement of Work*	WTP Contract

5.2 Other References

Document Number	Rev	Title
24590-LAW-3ZD-20-00002	000	*LAW Facility Design Description*
24590-LAW-M6C-ARV-00001	001	*ARV System Sizing Calculation for LAB and LAW*
24590-LAW-M6C-CHW-00001	000	*LAW Facility Chilled Water System Distribution Pipe Sizing*
24590-LAW-M6C-ISA-00001	001	*LAW Instrument Service Air System Sizing*
24590-LAW-M6C-LPS-00001	000	*Line Sizing and Desuperheater Rating Calculation for Low Pressure Steam*
24590-LAW-M6C-SCW-00001	000	*Line Sizing and System Requirement Calculation for LAW Steam Condensate Water System*
24590-LAW-N1D-LOP-00001	004	*LOP-SCB-00001 and LOP-SCB-00002 -LAW- - Melter 1 and Melter 2 Submerged Bed Scrubbers (SBS)*
24590-LAW-N1D-LOP-00002	004	*LOP-VSL-00001 and LOP-VSL-00002 -LAW- Melter 1 and Melter 2 SBS Condensate Vessel*
24590-LAW-N1D-LOP-00003	003	*LOP-WESP-00001 and LOP-WESP-00002 LAW - Melter 1 and Melter 2 Wet Electrostatic Precipitator WESP*
24590-LAW-N1D-LOP-00004	001	*Corrosion Evaluation - LOP-Offgas Piping (Downstream of Film Cooler to SBS Entry)*
24590-LAW-N1D-LOP-00006	001	*LOP-PMP-00001 and 2 and 4 and 5 LAW – Melter 1 and 2 SBS Condensate Purge Pumps*
24590-LAW-N1D-LOP-00007	001	*LOP-PMP-00003A-B & LOP-PMP-00006A-B Melter 1 & 2 SBS Water Purge Pump – Primary & Standby*
24590-LAW-N1D-LOP-P0001	001	*LOP-SCB-00001 & LOP-SCB-00002 (LAW) Melter 1 and Melter 2 Submerged Bed Scrubbers (SBS)*
24590-LAW-N1D-LOP-P0002	001	*LOP-VSL-00001 & LOP-VSL-00002 (LAW) Melter 1 & Melter 2 SBS Condensate Vessel*
24590-LAW-N1D-LOP-P0003	000	*LOP-WESP-00001 & LOP-WESP-00002 (LAW) Melter 1 and Melter 2 Wet Electrostatic Precipitator (WESP)*

Document Number	Rev	Title
24590-LAW-N1D-LOP-P0004	000	*Plant Item Material Selection Data Sheet*
24590-LAW-N1D-LVP-00001	007	*LVP-SCB-00001 (LAW) - LAW Melter Offgas Caustic Scrubber - Corrosion Evaluation*
24590-LAW-N1D-LVP-00002	003	*LVP-TK-00001 LAW - Caustic Collection Tank*
24590-LAW-N1D-LVP-00003	004	*LVP-EXHR-00001A/B/C (LAW) Melter Offgas Exhauster*
24590-LAW-N1D-LVP-00004	003	*LVP-ADBR-00001A/B (LAW) Activated Carbon Bed Adsorber*
24590-LAW-N1D-LVP-00005	003	*LVP-HX-00001 - Catalytic Oxidizer Heat Recovery Exchanger*
24590-LAW-N1D-LVP-00006	003	*LVP-HTR-00002 - Catalytic Oxidizer Electric Heater*
24590-LAW-N1D-LVP-00007	004	*LVP-SCO-00001 - Thermal Catalytic Oxidizer*
24590-LAW-N1D-LVP-00008	003	*LVP-SCR-00001 - NO_x Selective Catalytic Reducer*
24590-LAW-N1D-LVP-00009	002	*LVP-HTR-00001A&B & LVP-HTR-00003A/B (LAW) - Melters Offgas HEPA Preheater*
24590-LAW-N1D-LVP-P0002	000	*LVP-TK-00001 (LAW)*
24590-LAW-RPT-ENG-02-001	003	*WDOH Code Compliance Matrix for LAW HVAC Systems*
24590-LAW-U0D-W16T-00001	002	*LAW Room Environment Data Sheet*
24590-WTP-3DP-G04B-00004	5	*Technical Requirements Management*
24590-WTP-3DP-G04B-00046	31	*Engineering Drawings*
24590-WTP-3DP-G04T-00901	26	*Design Change Control*
24590-WTP-3DP-G04B-00092	0	*System Verification*
24590-WTP-GPP-SIND-068	4B	*Heat and Cold Stress Prevention*
24590-WTP-M6C-DOW-00001	000	*WDOH Domestic Water Dynamic Flow Analysis*
24590-WTP-RPT-HV-02-001	2	*WTP Cost Benefit Analysis for C2 and C3 HVAC Systems*
CCN 026829	NA	*Federal Acquisition Regulation 52.243-7 Notification of Changes (Apr 1984)*
CCN 028405	NA	*Operations and Maintenance Area Temperature Control Design Change*
CCN 033590	NA	*HVAC BOD - 100 fpm Containment Velocity*
CCN 116112	NA	*Ventilation Exhaust Stack Design Data (Augmented)*

5.3 System Design Documents

Document Number	Title
P&IDs	
24590-LAW-M6-LOP-00001001	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-SCB-00001*
24590-LAW-M6-LOP-00001002	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-VSL-00001*
24590-LAW-M6-LOP-00001003	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-BULGE-00001*
24590-LAW-M6-LOP-00001004	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-WESP-00001*

Document Number	Title
24590-LAW-M6-LOP-00001005	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 FILM COOLER OFFGAS*
24590-LAW-M6-LOP-00001006	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-PMP-00003A/B*
24590-LAW-M6-LOP-00002001	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-SCB-00002*
24590-LAW-M6-LOP-00002002	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-VSL-00002*
24590-LAW-M6-LOP-00002003	*P&ID- LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-BULGE-00002*
24590-LAW-M6-LOP-00002004	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-WESP-00002*
24590-LAW-M6-LOP-00002005	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 FILM COOLER OFFGAS*
24590-LAW-M6-LOP-00002006	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-PMP-00006A/B*
24590-LAW-M6-LOP-00004001	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-FCLR-00002*
24590-LAW-M6-LOP-00004002	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 1 LOP-FCLR-00001*
24590-LAW-M6-LOP-00005001	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-FCLR-00004*
24590-LAW-M6-LOP-00005002	*P&ID - LAW LAW PRIMARY OFFGAS PROCESS SYSTEM MELTER 2 LOP-FCLR-00003*
24590-LAW-M6-LVP-00001001	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM COMBINED HEADER*
24590-LAW-M6-LVP-00001002	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM HEPA PREHEATERS*
24590-LAW-M6-LVP-00001003	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM HEPA FILTERS*
24590-LAW-M6-LVP-00001004	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM OFFGAS EXHAUSTERS LVP-EXHR-00001A*
24590-LAW-M6-LVP-00001005	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM OFFGAS EXHAUSTERS LVP-EXHR-00001B*
24590-LAW-M6-LVP-00001006	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM OFFGAS EXHAUSTERS LVP-EXHR-00001C*
24590-LAW-M6-LVP-00002001	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM CAUSTIC SCRUBBER BYPASS*
24590-LAW-M6-LVP-00002002	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM CAUSTIC SCRUBBER LVP-SCB-00001*
24590-LAW-M6-LVP-00002003	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM CAUSTIC COLLECTION TANK LVP-TK-00001*
24590-LAW-M6-LVP-00002004	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM SCRUBBER RECIRCULATION LOOP LVP-PMP-00003A/3B*

Document Number	Title
24590-LAW-M6-LVP-00002005	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM TRANSFER PUMPS LVP-PMP-00002A/B*
24590-LAW-M6-LVP-00002006	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM STACK DISCHARGE MONITORING SYSTEM*
24590-LAW-M6-LVP-00002007	*P&ID - LAW LAW SECONDARY OFFGAS VESSEL VENT PROCESS SYSTEM STACK DISCHARGE MONITORING SYSTEM*
24590-LAW-M6-LVP-00003001	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM EQUIPMENT VENTS*
24590-LAW-M6-LVP-00004001	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM MERCURY MITIGATION EQUIPMENT BYPASS*
24590-LAW-M6-LVP-00004002	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM MERCURY MITIGATION EQUIPMENT LVP-SKID-00001*
24590-LAW-M6-LVP-00004003	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM MERCURY MITIGATION EQUIPMENT LVP-ADBR-00001A/B*
24590-LAW-M6-LVP-00005001	*P&ID-LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM AMMONIA DILUTION SKID*
24590-LAW-M6-LVP-00005002	*P&ID - LAW - LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM SCO/SCR SKID*
Calculations	
24590-LAW-MKC-LOP-00005	*LAW WET ELECTROSTATIC PRECIPITATORS (WESP) OPERATING CONDITIONS AND PROCESS DESIGN REQUIREMENTS*
24590-LAW-M6C-LOP-00008	*OVERPRESSURE PROTECTION EVALUATION OF THE LAW PRIMARY OFF-GAS (LOP) SYSTEM*
24590-LAW-M6C-LOP-00004	*LINE SIZING FOR FILM COOLERS*
24590-LAW-M6C-LOP-00006	*OVERFLOW SIZING FOR SCRUBBERS LOP-SCB-00001&2*
24590-LAW-M6C-LOP-00007	*LAW FILM COOLER EMERGENCY AIR IN-BLEED LINE PRESSURE DROP*
24590-LAW-M6C-RLD-00006	*SBS CONDENSATE COLLECTION VESSEL SIZING (RLD-VSL-00005)*
24590-LAW-M6C-LOP-00001	*OVERFLOW DRAIN LINE SIZING FOR LOP-SCB-00001 & LOP-SCB-00002*
24590-LAW-ESQR-ENG-12-0089	*WEIGHT / SEISMIC / NOZZLE LOAD / LIFTING CALCULATIONS, J2625, SUBMERGED BED SCRUBBER FLUE OR OFF-GAS LAW*
24590-QL-POA-MKAS-00001-01-03	*ASME CODE - SUBMERGED BED SCRUBBER, FLUE OR OFF-GAS LAW VESSELS WITH INTERNAL COILS AND EXTERNAL HALF PIPE JACKET*
24590-QL-POA-MKAS-00001-01-16	*SUBMERGED BED SCRUBBER FLUE OR OFF-GAS LAW, WEIGHT / SEISMIC / NOZZLE LOAD / LIFTING CALCULATIONS*
24590-QL-POA-MKAS-00001-01-17	*SUBMERGED BED SCRUBBER FLUE OR OFF-GAS LAW, WEIGHT / SEISMIC / NOZZLE LOAD /LIFTING CALCULATIONS*
24590-QL-POA-MKAS-00001-01-18	*SUBMERGED BED SCRUBBER FLUE OR OFF-GAS LAW, WEIGHT / SEISMIC / NOZZLE LOAD / LIFTING CALCULATIONS*
24590-QL-POB-MVA0-00002-03-01	*CODE DESIGN FOR MELTER 1 SBS CONDENSATE VESSEL*
24590-QL-POB-MVA0-00002-03-02	*CODE DESIGN FOR MELTER 2 SBS CONDENSATE VESSEL*
24590-CM-POA-MEP0-00001-05-00037	*CALCULATION - CALCULATIONS FOR SR6AA MGS-21 HEAT EXCHANGER - LAW SBS CHILLED WATER HEAT EXCHANGER*

Document Number	Title
24590-CM-POA-MVA0-00007-01-02	*LAW SBS CONDENSATE RECEIPT VESSEL TLP-VSL-00009A B*
24590-CM-POA-MVA0-00007-01-06	*FINITE ELEMENT ANALYSIS OF VARIOUS NOZZLES ON LAW SBS CONDENSATE RECEIPT VESSEL*
24590-QL-POB-MVA0-00002-03-09	*NOZZLE EXTERNAL LOADING FOR MELTER 1 SBS CONDENSATE VESSEL*
24590-QL-POB-MVA0-00002-03-10	*NOZZLE EXTERNAL LOADING FOR MELTER 2 SBS CONDENSATE VESSEL*
24590-LAW-M6C-RLD-00015	*RLD-VSL-00004 OVERFLOW SIZING*
24590-QL-POA-MKE0-00001-07-01	*LAW-2 WESP PRESSURE VESSEL DESIGN CALCULATIONS*
24590-QL-POA-MKE0-00001-07-02	*LAW-1 WESP PRESSURE VESSEL DESIGN CALCULATIONS*
24590-QL-POA-MKE0-00001-07-03	*LAW WESP PRESSURE VESSEL SKIRT DESIGN CALCULATIONS*
24590-LAW-ESQR-ENG-12-0090	*LAW-2 WESP PRESSURE VESSEL DESIGN CALCULATIONS LAW-WESP PRESSURE VESSEL SKIRT DESIGN CALCULATIONS*
24590-LAW-ESQR-ENG-12-0091	*DOE 1020-CRPT 08-0406 REVIEW: LAW-1 WESP PRESSURE VESSEL DESIGN CALCULATION*
24590-LAW-ESQR-ENG-12-0092	*LAW-WESP PRESSURE VESSEL SKIRT DESIGN CALCULATIONS*
24590-LAW-U3C-PPJ-00002	*PFD CALCULATION FOR LAW WET ELECTROSTATIC PRECIPITATOR HIGH LEVEL INTERLOCKS*
24590-QL-POA-MKE0-00001-13-01	*DESIGN AND ANALYSIS REPORT - DMP-4145-LAW-DDR-001*
24590-LAW-M6C-LVP-00003	*PIPE SIZES FOR LAW LVP SYSTEMS*
24590-LAW-M6C-LVP-00004	*OFFGAS PIPE AND EXHAUSTER SIZING FOR LOP AND LVP SYSTEMS*
24590-LAW-M6C-LVP-00006	*CODE CASE UG-140 OVERPRESSURE PROTECTION EVALUATION OF THE LAW SECONDARY OFF-GAS (LVP) SYSTEMS*
24590-LAW-M6C-LVP-00008	*SET PRESSURE AND SPECIFICATIONS OF RUPTURE DISK PSE-0148 FOR THE LVP OFF-GAS SYSTEM*
24590-LAW-MEC-LVP-00003	*DESIGN PRESSURE AND DESIGN TEMPERATURE CALCULATION FOR LVP SYSTEM*
24590-QL-POA-MKH0-00001-18-00004	*STRUCTURAL ANALYSIS OF FLANDERS/CSC LVP HEPA FILTER UNIT*
24590-QL-POA-MKH0-00001-18-00005	*STRUCTURAL ANALYSIS OF FLANDERS/CSC LVP HEPA FILTER UNIT*
24590-RMCD-02782	*STRUCTURAL ANALYSIS OF FLANDERS/CSC LVP HEPA FILTER UNIT*
24590-RMCD-02877	*STRUCTURAL ANALYSIS OF FLANDERS/CSC LVP HEPA FILTER UNIT*
24590-CD-POC-MBT0-00007-02-00001	*MASS AND ENERGY BALANCE FOR LAW TCO UNIT & AMMONIA/AIR DILUTION SKID*
24590-QL-POA-MKAS-00003-06-00001	*LAW MELTER OFFGAS CAUSTIC SCRUBBER PROCESS*
24590-QL-POA-MKAS-00003-07-00005	*REPORT - LAW CAUSTIC SCRUBBER ASME CODE CALCULATION*
24590-LAW-MVC-LVP-00001	*SIZING CALCULATION FOR CAUSTIC COLLECTION TANK LVP-TK-00001*
CALC-W375LV-PR00022	*SYSTEM 234 LAW VESSEL VENTILATION CALCULATION*

Appendix A Test Objectives, Conditions, and Acceptance Criteria

NOTE: The testing activities included in this appendix are limited to those identified as needing to be performed by Startup or Commissioning to support the verification of requirements in Section 3. This appendix does not restrict Startup or Commissioning from performing other routine system functional testing or grooming.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.4.2.4	Combined LAW vitrification system test to verify the system NO_x emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** NO_x emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit.	Offgas system operational. Melters processing simulated waste.
3.4.2.5	Combined LAW vitrification system test to verify the system PM and PM10 emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** PM and PM10 emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.6	Combined LAW vitrification system test to verify the system Particulate Matter emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Particular Matter emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.7	Combined LAW vitrification system test to verify the system Hydrochloric Acid and chlorine gas emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Hydrochloric acid and chlorine gas emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.8	Combined LAW vitrification system test to verify the system Dioxin and Furin emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Dioxin and Furan TEQ emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.9	Combined LAW vitrification system test to verify the system Mercury emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Mercury emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.10	Combined LAW vitrification system test to verify the system Lead and Cadmium emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Lead and Cadmium emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.4.2.11	Combined LAW vitrification system test to verify the system Arsenic, Beryllium, and Chromium emissions comply with WTP Dangerous Waste Permit requirements.	**(TAC)** Arsenic, beryllium, and chromium emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.12	Combined LAW vitrification system test to verify the system emissions comply with WTP Dangerous Waste Permit requirements. Carbon monoxide emissions to be measured and recorded by a continuous monitoring system over an hourly rolling average.	**(TAC)** Carbon Monoxide emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.13	Combined LAW vitrification system test to verify the system emissions comply with WTP Dangerous Waste Permit requirements. Hydrocarbon emissions to be measured and recorded by a continuous monitoring system over an hourly rolling average.	**(TAC)** Hydrocarbon emissions below limits. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.4.2.14	Combined LAW vitrification system test to verify the system emissions comply with WTP Dangerous Waste Permit requirements. Organic emissions to be calculated in accordance with the formula in the WTP Dangerous Waste Permit.	**(TAC)** Achieve destruction and removal efficiency (DRE) of 99.99 % for the principal organic dangerous constituents. Specific test acceptance criteria will be listed in the Environmental Demonstration Test (EDT). Documentation for the EDT plan is not issued at the time of this revision of this SDD.	Air permit	Offgas system operational. Melters processing simulated waste.
3.6.2.1	Test to verify HEPA preheaters are capable of producing a minimum temperature increase of 10 C. **CTNs** LVP-TT-0001 LVP-TT-0005 LVP-TT-0136 LVP-TT-0137 LVP-YC-0138A LVP-YC-0138B LVP-YC-0154A LVP-YC-0154B LVP-YC-0154C LVP-YC-0154D LVP-YC-0154E LVP-YC-0154F	**(TAC)** Offgas temperature downstream of HEPA preheaters (LVP-HTR-00001A/B, VLP-HTR-00003A/B) increases by a minimum of 10 C.		

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.7.2.1	Test to verify mercury mitigation skid is capable of detecting high differential CO or CO_2 concentrations across the skid (indicating a fire) and closing the isolation valves within a maximum allowable time of 170 seconds. **CTNs** LVP-AT-0405 LVP-AT-0406 LVP-AT-0424 LVP-AT-0425 LVP-YV-0403 LVP-YV-0407 LVP-YV-0415 LVP-YV-0449 LVP-YV-0450	**(TAC)** Upon receipt of high differential CO or CO_2 signal, the bypass opens and the carbon bed inlet valves close in 170 seconds or less.		ISA, PCJ, PPJ systems.
3.7.2.3	Test to verify in-leakage to the isolated carbon adsorbers is less than 152 lb/hr.	**(TAC)** In-leakage flow rate to the isolated carbon adsorbers is no greater than 152 lb/hr.		
3.8.2.3	Test to verify the system can maintain sufficient motive force to pull offgas from the melter plena with a single exhauster operating. Begin the test with two exhausters running and both melters having a simulated cold cap. Shut off one of the two exhausters while prohibiting the third exhauster from coming on line. Shut off feed to the melters, stop injection of air and DIW to the film coolers, open isolation valves to the LOP standby gas lines. Repeat the test for each of the three exhausters. **CTNs** LVP-EXHR-00001A LVP-EXHR-00001B LVP-EXHR-00001C LMP-PDT/PDI-1410/1411 LMP-PDT-PDI-2410/2411	**(TAC)** Each exhauster runs individually for 2 hours without either melter plenum pressure exceeding the setpoint (**TBD**) on the melter plenum high-pressure safety interlock.	Table 4A-2 of the PDSA allows for other SS system reconfigurations as necessary to support the maintenance of the depression in the melter while the offgas system is running on only one exhauster. The 2 hour mission time ensures that the cold cap will be reduced sufficiently that any potential releases into the exhauster rooms will be well below the exposure standards. Refer to 24590-LAW-3ZD-LMP-00001, *Low-Activity Waste Melter Process System Design Description - System Design Description,* for more information on the melter plenum high-pressure safety interlock.	Begin the test under all normal melter operating conditions with both melters receiving simulated melter feed.
3.9.2.2.1	Test to verify interlock opens the valve on the in-bleed assembly upon detection of high temperature in the film cooler outlet. **CTNs**: LOP-TT-1152 LOP-YV-1401 LOP-TT-1153 LOP-YV-1402 LOP-TT-2152 LOP-YV-2401 LOP-TT-2153 LOP-YV-2402	**(TAC)** Whenever the sensor measures a temperature above a setpoint (**TBD**) at a film cooler, the PPJ will open an air inlet valve to provide additional air cooling to that film cooler.		

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.2.2	Test to verify the interlock closes the demineralized water flush valve upon detection of WESP high liquid level. **CTNs** LOP-LT-1059 LOP-YC-1061 LOP-LT-2059 LOP-YC-2061	**(TAC)** On PPJ detection of high WESP liquid level (**TBD**), the DIW flush valve to the WESP is closed by the PPJ.		
3.9.2.2.3	Test to verify that upon detection of a high SBS level, the safety interlock shuts down the SBS condensate purge pump, closes the DIW and PSA isolation valves to the melter feed pumps, closes the DIW isolation valves to .the associated melter valve bulge, and closes DIW isolation valves to associated SBS condensate purge pump. **CTNs** LOP-LT-1011 LOP-YV-1029 (melter 1 DIW to bulge) LOP-YV-1148 (melter 1 DIW to bulge) CTNs for purge pump priming lines TBD. LFP-YV-1207 LFP-YV-1208 LOP-PMP-00003A LOP-JY-1012 LOP-PMP-00003B LOP-JY-1069 LOP-LT-2011 LOP-YV-2029 (melter 2 DIW to bulge) LOP-YV-2148 (melter 2 DIW to bulge) CTNs for purge pump priming lines TBD. LFP-YV-2207 LFP-YV-2208 LOP-PMP-00006A LOP-JY-2012 LOP-PMP-00006B LOP-JY-2069	**(TAC)** Upon SBS high level signal through the PPJ, DIW and PSA supply to melter feed pumps is terminated and the operating SBS condensate purge pump is isolated.	LOP-LT-1011 and LOP-LT-2011 perform Air Permit and safety functions. The indications are displayed by the PCJ. Shutting DIW and PSA supply to the melter feed pumps terminates feed to the melter.	Pump power, liquid in SBS, and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.2.4	Test to verify that upon detection of a low SBS level, the safety interlock shuts down the SBS condensate purge pump and closes the DIW and PSA isolation valves to the melter feed pumps. **CTNs** LOP-LT-1011 LFP-YV-1207 LFP-YV-1208 LOP-PMP-00003A LOP-JY-1012 LOP-PMP-00003B LOP-JY-1069 LOP-LT-2011 LFP-YV-2207 LFP-YV-2208 LOP-PMP-00006A LOP-JY-2012 LOP-PMP-00006B LOP-JY-2069	**(TAC)** Upon SBS low level signal through the PPJ DIW and PSA supply to melter feed pumps is terminated and the operating SBS condensate purge pump is isolated.	LOP-LT-1011 and LOP-LT-2011 perform Air Permit and safety functions. The indications are displayed by the PCJ. Shutting DIW and PSA supply to the melter feed pumps terminates feed to the melter.	Pump power, liquid in SBS, and PPJ systems.
3.9.2.3.1	Test to verify the interlock isolates the non-safety and de-energizes the safety heating elements, upon detection of a high outlet temperature (**TBD**) from the pre-heaters. **CTNs** LVP-TT-0136 LVP-TT-0137 LVP-HTR-00001A LVP-HTR-00003A LVP-YC-0138A LVP-YC-0138B LVP-HTR-00001B LVP-HTR-00003B LVP-YC-0154A LVP-YC-0154B LVP-YC-0154C LVP-YC-0154D LVP-YC-0154E LVP-YC-0154F	**(TAC)** Upon detection high temperature downstream of the pre-heaters (**TBD**) by the PPJ, non-Safety elements are isolated and Safety heating elements are de-energized.		PCJ and PPJ systems

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.3.2	Test to verify the interlock isolates the non-safety and energizes the safety heating elements, upon detection of a low differential temperature across the pre-heaters. **CTNs** LVP-TT-0001 LVP-TT-0005 LVP-HTR-00001A LVP-HTR-00003A LVP-YC-0138A LVP-YC-0138B LVP-HTR-00001B LVP-HTR-00003B LVP-YC-0154A LVP-YC-0154B LVP-YC-0154C LVP-YC-0154D LVP-YC-0154E LVP-YC-0154F	**(TAC)** Upon detection of a low differential temperature across the pre-heaters (**TBD**) by the PPJ, power is isolated to the non-safety elements and the safety elements are energized. Additional safety heating elements are energized, as necessary, to achieve a minimum differential temperature.	Downstream temperature is monitored by LVP-TE-0005 and TE-0137. Isolation of non-ITS elements is by LVP-JY-0138A and JY-0138B. De-energizing is by LVP-JY-0138C and JY-0138D.	PCJ and PPJ systems.
3.9.2.3.3	Test to verify the interlock terminates feed to both melters upon detection of a high differential pressure across the HEPA filters in the offgas stream. **CTNs** LVP-PDT-0083 LVP-PDT-0084 LVP-YV-0105 LVP-YV-0106 LVP-YV-0107 LVP-YV-0108 LFP-YV-1207 LFP-YV-1208 LFP-YV-2207 LFP-YV-2208	**(TAC)** Upon a high differential pressure signal transmitted through the PPJ, LVP-YV-0108, LFP -YV-1207, LFP -YV-1208, LFP -YV-2207, and LFP -YV-2208 terminate DIW and PSA to melter feed pumps for all melters.		LFP, PSW, ISA, PCJ and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.3.4	Test to verify the HEPA filter isolation valves cannot isolate both filter trains at the same time. • Close valve LVP-YV-0105, then attempt to close valves LVP-YV-0107 and LVP-YV-0108. • Close valve LVP-YV-0106, then attempt to close valves LVP-YV-0107 and LVP-YV-0108. • Close valve LVP-YV-0107, then attempt to close valves LVP-YV-0105 and LVP-YV-0106. • Close valve LVP-YV-0108, then attempt to close valves LVP-YV-0105 and LVP-YV-0106. **CTNs** LVP-ZSL-0105 LVP-ZSL-0106 LVP-ZSL-0107 LVP-ZSL-0108 LVP-YV-0105 LVP-YV-0106 LVP-YV-0107 LVP-YV-0108	**(TAC)** If any isolation valve on one of the parallel trains paths is closed (detected by "not open"), and one of the valves on the other train begins to close (detected by "not open"), the PPJ forces all four isolation valves to open.	Test to verify HEPA filter isolation value interlocks prevent simultaneous isolation of both filter trains, and that non-manual isolation valves fail in "open" position if control signal or motive power is lost.	ISA, PCJ and PPJ systems.
3.9.2.3.4	Test to verify that non-manual isolation valves fail in "open" position if control signal or motive power is lost. **CTNs** TBD	**(TAC)** Upon loss of control signal or motive power, the non-manual isolation valves fail in "open" position.		ISA, PCJ and PPJ systems.
3.9.2.4.1	Test to verify the interlock opens the bypass valve upon detection of a high differential pressure in the mercury mitigation skid. **CTNs** LVP-PDT-0401 LVP-PDT-0402 LVP-YV-0403	**(TAC)** Upon detection of mercury mitigation skid high differential pressure setpoint (**TBD**) in either pressure transducer by the PPJ, the mercury mitigation skid bypass valve opens.		ISA, PCJ and PPJ systems.
3.9.2.4.2	Test to verify the interlock opens the mercury mitigation skid bypass valve, and closes the offgas inlet valve to both carbon adsorbers upon detection of a high temperature in the offgas inlet to the mercury mitigation skid. **CTNs** LVP-TE-0404 LVP-TE-0434 LVP-YV-0403B LVP-YV-0407B LVP-YV-0415B LVP-YV-0449B LVP-YV-0450B	**(TAC)** Upon detection of a high inlet temperature (**TBD**) by the PPJ, the bypass valve opens and the carbon absorber inlet valves close.	There will be a short time delay after opening the bypass valve before the inlet valves to the carbon absorbers are closed.	ISA, PCJ and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.4.3	Test to verify the interlock opens the bypass valve, closes offgas inlet and outlet valves of both carbon absorbers, and terminates feed to the melters, upon detection of high differential CO or CO_2 concentration. **CTNs** LVP-AE-0405/0406 LVP-AE-0424/0425 LVP-LY-0403B LYP-YV-0407B LYP-YV-0415B LYP-YV-0449B LYP-YV-0450B LFP -YV-1207 LFP-YV-1208 LFP-YV-2207 LFP-YV-2208	**(TAC)** Upon detection of a high differential CO_x signal (**TBD**) by the PPJ, the mercury mitigation skid bypass opens, carbon bed inlet and outlet isolation valves close, and PSA and DIW supply to the melter feed pumps is terminated.	Shut off of DIW supply to the melter feed pumps may wait until after line flushes with a time delay built into the controls. The interlock control logic will ensure the mercury mitigation skid by pass valve is opened prior to closure of carbon absorber inlet isolation valves.	LFP, PSW, ISA, PCJ and PPJ systems.
3.9.2.5.1	Test to verify the interlock opens the bypass valve upon detection of high differential pressure across the SCO/SCR skid. **CTNs** LVP -PDT-0502 LVP -PDT-0504 LVP -YV-0501	**(TAC)** Upon detection of a high differential pressure (**TBD**) signal by the PPJ, the SCO/SCR bypass valve opens.		ISA, PCJ and PPJ systems.
3.9.2.5.2	Test to verify the interlock isolates power to the SCO/SCR skid heaters upon detection of high temperature downstream of the SCO/SCR skid heater. **CTNs** LVP-HTR-00002 LVP-TT-0509 LVP -TT-0516 LVP -JY-0510	**(TAC)** Upon detection of a high temperature (**TBD**) at the outlet of the skid heater by the PPJ, power to the Catalyst Skid heaters is isolated.		PCJ and PPJ systems.
3.9.2.5.3	Test to verify the interlock isolates ammonia flow and isolates the skid heaters, upon detection of a high temperature on the SCO/SCR skid outlet. **CTNs** LVP-SKID-00002 LVP-TT-0552 LVP-TT-0554 LVP-JY-0510 LVP-YV-0528	**(TAC)** Upon detection of a high SCO/SCR skid outlet temperature (**TBD**), the PPJ isolates ammonia flow to the SCO/SCR skid and isolates the SCO/SCR heater.		AMR, ISA, PCJ and PPJ systems.
3.9.2.5.4	Test to verify the interlock isolates the ammonia flow to the SCO/SCR skid, upon detection of a low SCO/SCR skid heater outlet temperature. **CTNs** LVP-SKID-00002 LVP-TT-0552 LVP-TT-0554 LVP-YV-0528	**(TAC)** Upon detection of a low SCO/SCR skid outlet temperature (**TBD**), the PPJ isolates ammonia flow to the SCO/SCR skid.		AMR, ISA, PCJ and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.5.5	Test to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of high ammonia supply flow. **CTNs** LVP-FT-0530 LVP-FT-0531 LVP-YV-0528	**(TAC)** Upon detection of a high ammonia flow signal the PPJ isolates ammonia flow to the SCO/SCR skid.		AMR, ISA, PCJ and PPJ systems.
3.9.2.5.6	Test to verify the interlock closes the isolation valve on the ammonia supply line, upon detection of dilution-air flow below the minimum allowable. **CTNs** LVP-FT-0540 LVP-FT-0541 LVP-YV-0528 LVP-YV-0538	**(TAC)** When a decreased/reverse dilution air flow is detected, the ammonia supply isolation valve is closed. Upon detection of a low dilution air flow signal, the PPJ isolates ammonia flow to the SCO/SCR skid.		ISA, PSW, PCJ and PPJ systems.
3.9.2.5.7	Test to verify the ammonia supply isolation valve closes upon a loss of control signal or loss of actuating power **CTNs** LVP-YC-0528 LVP-YV-0528	**(TAC)** Upon a loss of signal or power to LVP-YC-0528, the ammonia isolation valve closes.		AMR, ISA, PCJ and PPJ systems.
3.9.2.6.1	Test to verify the interlock closes the caustic scrubber recirculation and spray water valves, and opens the bypass valve upon detection of high differential pressure across the caustic scrubber. **CTNs** LVP-PDT-0047 LVP-PDT-0094 LVP -YV-0219 LVP -YV-0201 LVP -YV-0097	**(TAC)** Upon detection of a high differential pressure (**TBD**) across the caustic scrubber by the PPJ, the caustic scrubber recirculation line isolation valve closes, the caustic scrubber spray water addition control valve closes, and the caustic scrubber bypass valve opens.		ISA, PSW, PCJ and PPJ systems.
3.9.2.6.2	Test to verify the interlock closes the recirculation line isolation valve for the caustic scrubber upon detection of low pressure in the caustic scrubber recirculation line. **CTNs** LVP-PDT-0047 LVP-PDT-0094 LVP-YV-0219	**(TAC)** Upon detection of a low pressure (**TBD**) in the caustic scrubber recirculation line by the PPJ, the recirculation line valve is closed.		ISA, PCJ and PPJ systems.
3.9.2.6.3	Test to verify the interlock terminates feed to the melter upon detection of low flow rate in the caustic scrubber recirculation line. **CTNs** LVP-FT-0221 LFP-YV-1207 LFP-YV-1208 LFP-YV-2207 LFP-YV-2208	**(TAC)** Upon detection of a low flow rate (**TBD**) in the caustic scrubber recirculation line, PSA and DIW is isolated from the melter feed pumps.		LVP-PMP-00003A or 3B circulating caustic solution (or PSW in caustic tank).

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.6.4	Test to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection that the caustic scrubber bypass valve is no longer closed. **CTNs** LVP-YV-0097 LVP-HTR-00002 LVP-JY-0510 LVP-YV-0528 LVP-YV-0501	**(TAC)** Upon the PPJ detection that the caustic scrubber bypass valve is not closed, the heater shuts down, ammonia supply isolates, and the SCO/SCR bypass valve opens.		AMR, ISA, PCJ and PPJ systems.
3.9.2.6.5	Test to verify the interlock isolates power to the catalytic oxidizer electric heater, isolates the ammonia supply to the SCO/SCR skid, and opens the SCO/SCR bypass valve upon detection of high offgas temperature downstream of the caustic scrubber outlet. **CTNs** LVP-TT-0236 LVP-TT-0237 LVP-JY-0510 LVP-YV-0528 LVP-YV-0538 LVP-YV-0501	**(TAC)** Upon detection of a high temperature (**TBD**) downstream of the caustic scrubber by the PPJ, the catalytic oxidizer heater is shutdown, SCO/SCR skid bypass is opened, and ammonia supply is isolated.		AMR, ISA, PCJ and PPJ systems.
3.9.2.6.6	Test to verify the interlock closes the process water line isolation valve upon detection of low pressure in the process water line. **CTNs** LVP-PT-0216 LVP-YV-0201	**(TAC)** Upon detection of a low pressure signal (**TBD**) in the process water line input to the caustic scrubber by the PPJ, the PSW supply line valve is isolated.		ISA, PSW, PCJ and PPJ systems.
3.9.2.7.1	Test to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, stops feed to the melters, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when a low LVP header vacuum is detected. **CTNs** LVP-PT-0139 LVP-PT-0140 LFP-YV-1208A/B LFP-YV-2208A/B LVP-YC-0072 LVP-PC-0072 LVP-YC-0403A/B LVP-YC-0501A/B LVP -YV-0528 LVP -YV-0538 LVP-YC-0097A/B LVP-YC-0017B LVP-YC-0020B LVP-YC-0023B	**(TAC)** Upon detection of a low (**TBD**) header vacuum by the PPJ, exhausters are set to fixed speed, bypass valves open in the secondary offgas process system (mercury mitigation skid, SCO/SCR skid, and caustic scrubber), vessel vent pressure control valve closes, PSA and DIW is isolated from the melter feed pumps.		LFP, PSW, AMR, ISA, PCJ and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.7.2	Test to verify the interlock sets exhausters to a fixed speed, opens the bypass valves in the secondary offgas system, closes the vessel vent header pressure control valve, closes the isolation valve on the ammonia supply to the SCR, and closes the isolation valve on the dilution-air supply to the SCR when excessive LVP header vacuum is detected. **CTNs** LVP-PT-0139 LVP-PT-0140 LVP-YC-0072 LVP-PC-0072 LVP-YC-0403A/B LVP-YC-0501A/B LVP -YV-0528 LVP -YV-0538 LVP-YC-0097A/B LVP-YC-0017B LVP-YC-0020B LVP-YC-0023B	**(TAC)** Upon detection of a high (**TBD**) header vacuum by the PPJ, exhausters are set to fixed speed, bypass valves open in the secondary offgas process system (mercury mitigation skid, SCO/SCR skid, and caustic scrubber), and vessel vent pressure control valve closes.		AMR, ISA, PCJ and PPJ systems.
3.9.2.8.1	Test to verify the interlock closes the normal supply isolation valve, and opens the backup supply isolation valve upon detection of low pressure in the normal purge air supply. **CTNs** LVP-PT-0164 LVP-EXHR-00001A LVP-YV-0159 LVP-YV-0157 LVP-PNL-00017 LVP-PNL-00018 LVP-EXHR-00001B LVP-YV-0161 LVP-YV-0163 LVP-PNL-00020 LVP-PNL-00021 LVP-EXHR-00001C LVP-YV-0167 LVP-YV-0165 LVP-PNL-00023 LVP-PNL-00024	**(TAC)** Upon detection of low-pressure (**TBD**) signal in the ISA purge air supply by the PPJ ISA to the normal purge air to the exhauster shaft seals is isolated and the valve between the exhauster shaft seals and the backup purge air supply is opened.		ISA, PCJ and PPJ systems.
3.9.2.8.2	Test to verify the interlock terminates feed to both melters upon detection of low pressure in the backup purge air supply. **CTNs** LVP-PT-0164 LFP-YV-1208A/B LFP-YV-2208A/B	**(TAC)** Upon detection of a low pressure (**TBD**) in the ISA purge air to the exhauster shaft seals, PSA and DIW is isolated from the melter feed pumps.		LFP, PSW, ISA, PCJ and PPJ systems.

Requirement (para #)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.9.2.8.3	Test to verify the exhauster backup purge air supplies adequate pressure to the associated exhauster shaft seal for at least 2 hours after reaching backup air supply low pressure setpoint. Isolate ISA air from the purge air panel and open supply to the bottled air to the purge air panel for the exhauster being tested. **CTNs:** LVP-EXHR-00001A LVP-YV-0159 LVP-YV-0157 LVP-PNL-00017 LVP-PNL-00018 LVP-EXHR-00001B LVP-YV-0161 LVP-YV-0163 LVP-PNL-00020 LVP-PNL-00021 LVP-EXHR-00001C LVP-YV-0167 LVP-YV-0165 LVP-PNL-00023 LVP-PNL-00024	**(TAC)** Back up bottled supply air for purge air lasts for at least 2 hours while maintaining a nominal backpressure of 25 psig on the seals as read on the tested exhauster's purge air panels.	The regulator on the purge air panels is set to 25 psig. The 2 hour mission time ensures that before any of the exhauster shaft seals fail, the cold cap will be reduced sufficiently that any potential releases into the exhauster rooms will be well below the exposure standards.	Single test will be run with one exhauster to confirm adequate air pressure is available at the shaft seal.

* NOTE: Test Acceptance Criteria (TAC) are based on requirements from authorization basis documents and General Test Criteria (GTC) are requirements from other sources.

Appendix B Descriptions of System Functional Flow and Interactions

Function: A.1	Ventilate (Draw) Melter Offgas
Detail description: The LOP system draws offgas from the LAW melters, maintains a negative pressure in the melter plenums, offgas equipment, and piping relative to adjacent areas, and confines hazardous gases.	
Initiation: This function initiates during Melter startup and LOP/LVP startup.	
Termination: This function terminates during Melter shut down.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.2	Cool Melter Offgas
Detail description: The LOP system cools the offgas enabling subsequent treatment. Cooling is performed by the offgas film cooler and submerged bed scrubber (SBS).	
Initiation: This function initiates during Melter startup and LOP/LVP startup	
Termination: This function terminates during Melter shut down.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.3	Remove Particulates and Aerosols
Detail description: Remove radioactive entrained particulates and aerosols from the offgas stream via the SBS and WESP.	
Initiation: This function initiates during Melter startup and LOP/LVP startup	
Termination: This function terminates during Melter shut down.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.4	Ventilate Vessels
Detail description: Ventilate process system vessels (LCP, LFP, and RLD) and LOP/LVP startup.	
Initiation: This function initiates during LCP, LFP, RLD tanks in use.	
Termination: This function terminates when Tanks are not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.5	Preheat Offgas
Detail description: Preheat offgas stream prior to the high-efficiency particulate air (HEPA) filters to prevent moisture condensation and subsequent blinding of the HEPA filters.	
Initiation: This function initiates during Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: This function terminates during Melter shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.6	Remove Particulates
Detail description: Remove radioactive-entrained particulates from the offgas stream via HEPA filters.	
Initiation: This function initiates during Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: This function terminates during Melter shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.7	Treat offgas
Detail description: Treat offgas to remove principal organic dangerous constituents (PODCs) and hazardous emissions. Transfer scrubber effluents to the caustic collection vessel. Scrubber effluent collected by the caustic collection vessel is sent to either the RLD system in PT facility (baseline configuration) or the DEP system in the EMF (DFLAW configuration) for further treatment/disposal.	
Initiation: This function initiates during Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: This function terminates during Melter shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: A.8	Exhaust
Detail description: The LOP and LVP systems maintain all components at a lower pressure relative to the room or gallery in which they reside. One set of fans and air injection provide the motive force to the offgas through the exhaust stack.	
Initiation: This function initiates during Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: This function terminates during Melter shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: B.1	Inject Diluted Ammonia
Detail description: Inject Diluted Ammonia/air mixture into the catalytic oxidizer/reducer skid (SCO/SCR) to reduce NO_x to nitrogen and water vapor.	
Initiation: This function initiates during Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: This function terminates when Melter is shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: C.1	Actuate Valves
Detail description: ISA provides the motive force to safety and non-safety valves on the LOP and LVP systems and supply instrumentation purge for the LVP system.	
Initiation: This function initiates during startup of LOP/LVP.	
Termination: This function terminates when LOP/LVP is shutdown or Melter shutdown.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: D.1	Receive Electrical Power
Detail description: The low voltage electrical (480/208/120 V) system (LVE) provides electrical power to the non-safety LOP/LVP equipment and instruments.	
Initiation: This function initiates during startup of LOP/LVP.	
Termination: This function terminates when LOP/LVP is shutdown or Melter shutdown.	
Parallel or sequential functions: All	
Applicable Modes: Normal Operations	

Function: E.1	Remove/Package & Replace Components
Detail description: Disconnect/reconnect and remove/replace LOP/LVP components. Consumable components on the LOP/LVP will be assisted in replacement by interfacing with the RWH system.	
Initiation: This function initiates when LOP/LVP components require replacement.	
Termination: This function terminates when replacement of LOP/LVP components are complete.	
Parallel or sequential functions: All maintenance functions	
Applicable Modes: Maintenance	

Function: F.1	Process Control System
Detail description: Non-Safety monitoring and control functions are supported by the PCJ. Components that are controlled automatically by the PPJ are also monitored by the PCJ during normal operations.	
Initiation: Melter startup or LCP, LFP, RLD tanks in use and LOP/LVP startup.	
Termination: Melter shut down and Tanks not in use.	
Parallel or sequential functions: All	
Applicable Modes: LOP/LVP startup, Normal Operations, and not credited for DBE	

Function: F.2	PPJ
Detail description: Safety Instrumented Functions and Alarms. Automatic Safety monitoring and control functions are supported by the PPJ.	
Initiation: This function initiates when the LAW Facility is in startup operations	
Termination: This function terminates when LAW glass production operations are complete.	
Parallel or sequential functions: All	
Applicable Modes: All	

Appendix C Active Safety Instruments and Functions

The listed instruments are designated as having active safety functions, implemented through interface with and programming in the PPJ system. Information in the following table reflects the current design of active safety instruments, including functions and safety designations per the P&IDs and associated equipment and instrument lists. In some cases, the current safety classification of the SSCs in design is known to exceed the design requirements. The information will be updated as needed to reflect changes to the design. The information below is provided in support of Plant Engineering and Operations and does not represent design requirements.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 1 Primary Offgas Line High Temperature Interlock	SS	LOP -TT-1152	LOP -YV-1401 via LOP -YC-1401	Whenever the sensor measures a temperature above a predefined setpoint, the function will open an air inlet valve to provide additional air cooling to each film cooler.
Melter 1 Standby Offgas Line High Temperature Interlock	SS	LOP -TT-1153	LOP -YV-1402 via LOP -YC-1402	Whenever the sensor measures a temperature above a predefined setpoint, the function will open an air inlet valve to provide additional air cooling to each film cooler.
Melter 2 Primary Offgas Line High Temperature Interlock	SS	LOP -TT-2152	LOP -YV-2401 via LOP -YC-2401	Whenever the sensor measures a temperature above a predefined setpoint, the function will open an air inlet valve to provide additional air cooling to each film cooler.
Melter 2 Standby Offgas Line High Temperature Interlock	SS	LOP -TT-2153	LOP -YV-2402 via LOP -YC-2402	Whenever the sensor measures a temperature above a predefined setpoint, the function will open an air inlet valve to provide additional air cooling to each film cooler.
Melter 1 WESP High Level Interlock	SS	LOP-LT-1059	LOP -YV-1061 via LOP -YC-1061	On detection of high WESP liquid level, the demineralized water flush valve to the WESP is closed.
Melter 2 WESP High Level Interlock	SS	LOP-LT-2059	LOP -YV-2061 via LOP -YC-2061	On detection of high WESP liquid level, the demineralized water flush valve to the WESP is closed.
Melter 1 SBS High Level Interlock	SS	LOP -LT-1011	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LOP -JY-1012 via LOP -YC-1012B, LOP -JY-1069 via LOP -YC-1069B LOP-YV-1029 LOP-YV-1148	On detection of high SBS level, the water purge pumps are stopped and melter feed are isolated, DIW to the melter valve bulge is isolated

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 2 SBS High Level Interlock	SS	LOP -LT-2011	LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B, LOP -JY-2012 via LOP -YC-2012B, LOP -JY-2069 via LOP -YC-2069B LOP-YV-2029 LOP-YV-2148	On detection of high SBS level, the water purge pumps are stopped and melter feed are isolated, DIW to the melter valve bulge is isolated
Melter 1 SBS Low Level Interlock	SS	LOP -LT-1011	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LOP -JY-1012 via LOP -YC-1012B, LOP -JY-1069 via LOP -YC-1069B	On detection of low SBS level, the water purge pumps are stopped and melter feed is isolated.
Melter 2 SBS Low Level Interlock	SS	LOP -LT-2011	LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B, LOP -JY-2012 via LOP -YC-2012B, LOP -JY-2069 via LOP -YC-2069B	On detection of low SBS level, the water purge pumps are stopped and melter feed is isolated.
Offgas HEPA Preheater High Temperature Interlock	SS	LVP -TT-0136 LVP -TT-0137	LVP -JY-0138A via LVP -YC-0138A, LVP -JY-0138B via LVP -YC-0138B LVP -JY-0154A via LVP -YC-0154A LVP -JY-0154B via LVP -YC-0154B LVP -JY-0154C via LVP -YC-0154C LVP -JY-0154D via LVP -YC-0154D LVP -JY-0154E via LVP -YC-0154E LVP -JY-0154F via LVP -YC-0154F	When sensors indicate the temperature is high, the safety system acts to isolate power to the non-safety heaters and de-energized the safety heaters..

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Offgas HEPA Preheaters Differential Temperature Interlock	SS	LVP -TT-0001 LVP -TT-0005	LVP -JY-0138A via LVP -YC-0138A, LVP -JY-0138B via LVP -YC-0138B LVP -JY-0154A via LVP -YC-0154A LVP -JY-0154B via LVP -YC-0154B LVP -JY-0154C via LVP -YC-0154C LVP -JY-0154D via LVP -YC-0154D LVP -JY-0154E via LVP -YC-0154E LVP -JY-0154F via LVP -YC-0154F	On detection of low or high temperature difference across preheaters, the non-safety heaters are isolated and the safety heaters are turned on or off respectively.
High Differential Pressure Across HEPA Filters	SS	LVP-PDT-0083 LVP-PDT-0084	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B	On detection of a high differential pressure signal across the HEPA filters melter feed is isolated.
Offgas HEPA Isolation Valve Interlock	SS	LVP -ZSH - 0105 LVP -ZSH - 0106 LVP -ZSH - 0107 LVP -ZSH - 0108	LVP -YV-0105 via LVP -YC-0105B, LVP -YV-0106 via LVP -YC-0106B, LVP -YV-0107 via LVP -YC-0107B, LVP -YV-0108 via LVP -YC-0108B	If either isolation valve on one of the parallel paths is not open and one of the valves on the other train begins to close (detected by not open), the PPJ will force all four isolation valves to open.
Mercury Mitigation Skid Differential Pressure Interlock	SS	LVP -PDT-0401 LVP -PDT-0402	LVP -YV-0403 via LVP -YC-0403B	Whenever the differential pressure on either instrument is high the function opens the bypass valve around the mercury mitigation system.
Mercury Mitigation High Inlet Temperature Interlock	SS	LVP -TT-0404 LVP -TT -0434	LVP -YV-0403 via LVP -YC-0403B, LVP -YV-0407 via LVP -YC-0407B, LVP -YV-0415 via LVP -YC-0415B, LVP -YV-0449 via LVP -YC-0449B,	Whenever the temperature on either sensor is above a predetermined setpoint the function opens the mercury mitigation system bypass valve and then (after short time delay) closes the inlet valves to each of the two adsorbers.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
			LVP -YV-0450 via LVP -YC-0450B	
Mercury Mitigation High Differential CO_x Interlock	SS	LVP -AT-0405 LVP -AT-0406 LVP -AT-0424 LVP -AT-0425	LVP -YV-0403 via LVP -YC-0403B, LVP -YV-0407 via LVP -YC-0407B, LVP -YV-0415 via LVP -YC-0415B, LVP -YV-0449 via LVP -YC-0449B, LVP -YV-0450 via LVP -YC-0450B	The function compares two pairs of input and output analyzers, and if either difference is high, opens the mercury mitigation system bypass valve and then (after short time delay) closes the inlet valves.
Catalytic Oxidizer/Reducer Skid LVP-SKID-00002 Differential Pressure Interlock	SS	LVP -PDT-0502 LVP -PDT-0504	LVP -YV-0501 via LVP -YC-0501B	Whenever the differential pressure of either sensor is above a predefined setpoint the function opens a bypass valve to open a flowpath around the catalytic oxidizer / reducer skid.
Catalytic Oxidizer/Reducer Electric Heater LVP-HTR-00002 High Temperature Interlock	SS	LVP -TT-0509 LVP -TT-0516	LVP -JY-0510 via LVP -YC-0510	Whenever the temperature is above a predetermined setpoint the function isolates electrical power to the heater.
Catalytic Oxidizer/Reducer Unit Skid LVP-SKID-00002 High Outlet Temperature Interlock	SS	LVP -TT-0552 LVP -TT-0554	LVP -JY-0510 via LVP -YC-0510, LVP -YV-0528 via LVP -YC-0528	Whenever a sensor measures a temperature above a predefined setpoint the function will isolate power to the electric heater and then isolate the ammonia flow to the SCR

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Catalytic Oxidizer/Reducer Unit Skid LVP-SKID-00002 Low Outlet Temperature Interlock	SS	LVP -TT-0552 LVP -TT-0554	LVP -YV-0528 via LVP -YC-0528	Whenever a sensor measures a temperature below a predefined setpoint the function will isolate the ammonia flow to the SCR
Catalytic Oxidizer/Reducer Low Dilution Air Flow Interlock	SS	LVP -FT-0540 LVP -FT-0541	LVP -YV-0528 via LVP -YC-0528, LVP -YV-0538 via LVP -YC-0538	This function isolates the air and ammonia supply valves when the dilution air flow reaches a predetermined low flow value on either sensor.
Catalytic Oxidizer/Reducer High Ammonia Flow Interlock	SS	LVP -FT-0530 LVP -FT-0531	LVP -YV-0528 via LVP -YC-0528	The system isolates the ammonia supply valve when the ammonia supply flow reaches a predetermined high flow rate on either sensor.
Caustic Scrubber High Differential Pressure Interlock	SS	LVP -PDT-0047 LVP -PDT-0094	LVP -YV-0097 via LVP -YC-0097B, LVP -YV-0201 via LVP -YC-0201, LVP -YV-0219 via LVP -YC-0219	If either sensor detects a high differential pressure the function opens the bypass valve allowing off gas air to bypass the scrubber, closes the process water inlet valve, and closes the caustic scrubber recirculation valve.
Caustic Scrubber Low Recirculation Pressure Interlock	SS	LVP -PT-0220	LVP -YV-0219 via LVP -YC-0219	Pressure below a predefined setpoint closes the caustic scrubber recirculation line isolation valve.
Caustic Scrubber Drain Seal Loop Interlock	SS	LVP -FT-0221	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B	On detection of low flow in the caustic recirculation line, the air to the ADS pumps is isolated, stopping feed to the melter.
Caustic Scrubber Bypass Valve Not Closed Interlock	SS	LVP -ZSL-0097	LVP -YV-0501 via LVP -YC-0501B, LVP -JC-0510 via LVP -YC-0510, LVP -YV-0528 via LVP -YC-0528	On detection of the caustic scrubber bypass valve no longer being closed, isolate power to the catalytic oxidizer electric heater, isolate the ammonia supply to the SCO/SCR skid, and open the SCO/SCR bypass valve.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Caustic Scrubber Outlet High Temperature Interlock	SS	LVP-TT-0236 LCP-TT-0237	LVP -YV-0501 via LVP -YC-0501B, LVP -JC-0510 via LVP -YC-0510, LVP -YV-0528 via LVP -YC-0528	On detection high temperature in the scrubber outlet, isolate power to the catalytic oxidizer electric heater, isolate the ammonia supply to the SCO/SCR skid, and open the SCO/SCR bypass valve.
Caustic Scrubber Service Water Line Low Pressure Interlock	SS	LVP -PT-0216	LVP -YV-0201 via LVP -YC-0201	On detection of low pressure in the PSW system the PSW isolation valve is closed.
Melter off Gas Reconfiguration Low LVP Header Vacuum (Exhauster Control) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YC-0017B LVP -YC-0020B LVP -YC-0023B	If either sensor detects a pressure below a predetermined setpoint and after a short time delay (10- 30 seconds to be determined) the system sets the two operating exhauster fans to a default speed.
Melter off Gas Reconfiguration Low LVP Header Vacuum (Bypass) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YV-0097 via LVP -YC-0097B, LVP -YV-0403 via LVP -YC-0403B, LVP -YV-0501 via LVP -YC-0501B	If either sensor detects a pressure below a predetermined setpoint and after a short time delay (10- 30 seconds to be determined), bypass valves for the scrubber, SCO/SCR, and carbon bed adsorbers are opened.
Melter off Gas Reconfiguration Low LVP Header Vacuum (Vessel Ventilation) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -PV-0072 via LVP -PY-0072B and LVP -YC-0072	If either sensor detects a pressure below a predetermined setpoint and after a short time delay (10-30 seconds to be determined), the vessel vent header pressure control valve is closed.
Melter off Gas Reconfiguration Low LVP Header Vacuum (Ammonia Supply Isolation) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YV-0528 via LVP -YC-0528, LVP -YV-0538 via LVP -YC-0538	If either sensor detects a pressure below a predetermined setpoint and after a short time delay (10-30 seconds to be determined) the system isolates the air and ammonia supply valves
Melter Off Gas Reconfiguration Low LVP Header Vacuum	SS	LVP -PT-0139 LVP -PT-0140	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B	If either sensor detects a pressure below a predetermined setpoint and after a short time delay (10-30 seconds to be determined) air and water are isolated from the ads pumps, stopping feed to both melters.
Melter off Gas Reconfiguration High LVP Header Vacuum (Exhauster Control) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YC-0017B LVP -YC-0020B LVP -YC-0023B	If either sensor detects a pressure above a predetermined setpoint and after a short time delay (10- 30 seconds to be determined) the system sets the two operating exhauster fans to a default speed.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter off Gas Reconfiguration High LVP Header Vacuum (Bypass) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YV-0097 via LVP -YC-0097B, LVP -YV-0403 via LVP -YC-0403B, LVP -YV-0501 via LVP -YC-0501B	If either sensor detects a pressure above a predetermined setpoint and after a short time delay (10- 30 seconds to be determined), bypass valves for the scrubber, SCO/SCR, and carbon bed absorbers are opened.
Melter off Gas Reconfiguration High LVP Header Vacuum (Vessel Ventilation) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -PV-0072 via LVP -PY-0072B and LVP -YC-0072	If either sensor detects a pressure above a predetermined setpoint and after a short time delay (10-30 seconds to be determined), the vessel vent header pressure control valve is closed.
Melter off Gas Reconfiguration High LVP Header Vacuum (Ammonia Supply Isolation) Interlock	SS	LVP -PT-0139 LVP -PT-0140	LVP -YV-0528 via LVP -YC-0528, LVP -YV-0538 via LVP -YC-0538	If either sensor detects a pressure above a predetermined setpoint and after a short time delay (10-30 seconds to be determined) the system isolates the air and ammonia supply valves
Melter Off Gas Reconfiguration HighLVP Header Vacuum	SS	LVP -PT-0139 LVP -PT-0140	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B	If either sensor detects a pressure above a predetermined setpoint or after a short time delay (10-30 seconds to be determined) air and water are isolated from the ads pumps, stopping feed to both melters.
Exhauster Seals Normal Air Purge Low Pressure Interlock	SS	LVP-PT-0156 LVP-PT-0160 LVP-PT-0164	LVP-YV-0157 via LVP-YC-0157 LVP-YV-0159 via LVP-YC-0159 LVP-YV-0161 via LVP-YC-0161 LVP-YV-0163 via LVP-YC-0163 LVP-YV-0165 via LVP-YC-0165 LVP-YV-0167 via LVP-YC-0167	If the sensor detects a low pressure signal on the ISA line for exhauster seal purge air, the ISA valve closes and the valve for backup bottled air opens.
Exhauster Seals Backup Air Purge Low Pressure Interlock	SS	LVP-PT-0156 LVP-PT-0160 LVP-PT-0164	LFP -YV-1207 via LFP -YC-1207B, LFP -YV-1208 via LFP -YC-1208B, LFP -YV-2207 via LFP -YC-2207B, LFP -YV-2208 via LFP -YC-2208B	If the sensor detects a low pressure signal on the ISA line for exhauster seal purge air, air and water are isolated from the ads pumps, stopping feed to both melters.
Melter 1 Offgas System Loss of Power Film Cooler Isolation Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -YV-1109 via LOP -YC-1109, LOP -YV-1129 via LOP -YC-1129	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, isolates air and water to the film cooler.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 2 Offgas System Loss of Power Film Cooler Isolation Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -YV-2109 via LOP -YC-2109, LOP -YV-2129 via LOP -YC-2129	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, isolates air and water to the film cooler.
Melter 1 Offgas System Loss of Power Offgas Flow Control Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -FV-1140 via LOP -FY-1140B and LOP -YC-1140	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the system opens the flow control valve for the WESP.
Melter 2 Offgas System Loss of Power Offgas Flow Control Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -FV-2140 via LOP -FY-2140B and LOP -YC-2140	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the system opens the flow control valve for the WESP.
Melter Offgas System Loss of Power Vessel Ventilation Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LVP -PV-0072 via LVP -PY-0072B and LVP -YC-0072	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the vessel vent header pressure control valve is closed.
Melter Offgas System Loss of Power Bypass Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LVP -YV-0097 via LVP -YC-0097B, LVP -YV-0403 via LVP -YC-0403B, LVP -YV-0501 via LVP -YC-0501B	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, bypass valves for the scrubber, SCO/SCR, and carbon bed adsorbers are opened.
Melter 1 Offgas System Loss of Power WESP Air Isolation Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -YV-1098 via LOP -YC-1098	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the air to WESP is isolated.
Melter 2 Offgas System Loss of Power WESP Air Isolation Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LOP -YV-2098 via LOP -YC-2098	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the air to WESP is isolated.
Melter Offgas System Loss of Power Exhauster Control Interlock	SS	UPE -YY-2303 UPE -YY-2403 UPE -YY-2503	LVP -YC-0017B, LVP -YC-0020B, LVP -YC-0023B	On loss of power to the three UPS units feeding power to the offgas adjustable speed drives (ASDs) and fans, the system then sets the two operating exhauster fans to a default speed.

Appendix D System Procedures

RESERVED

Appendix E System History

RESERVED